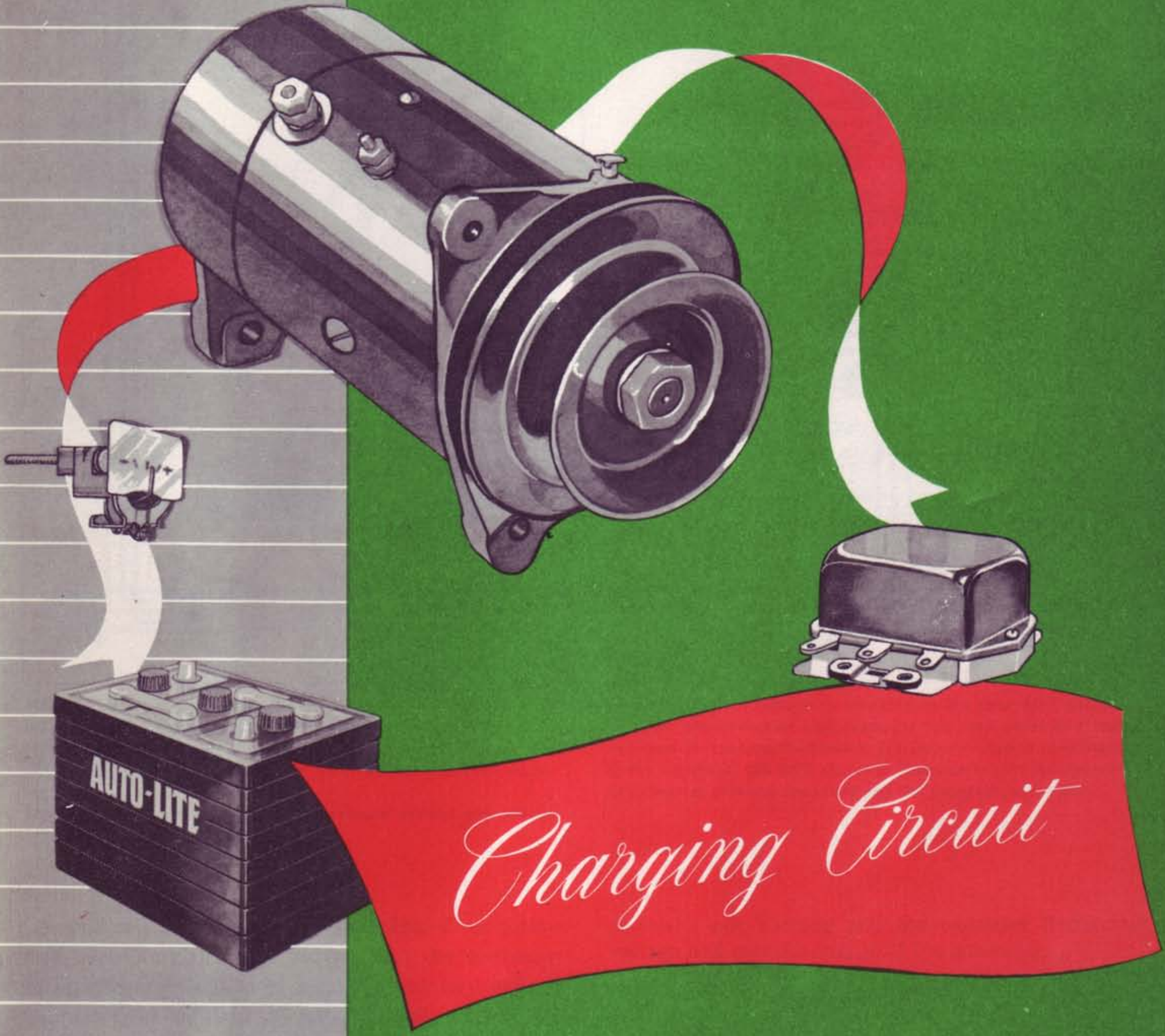


Charging Circuit

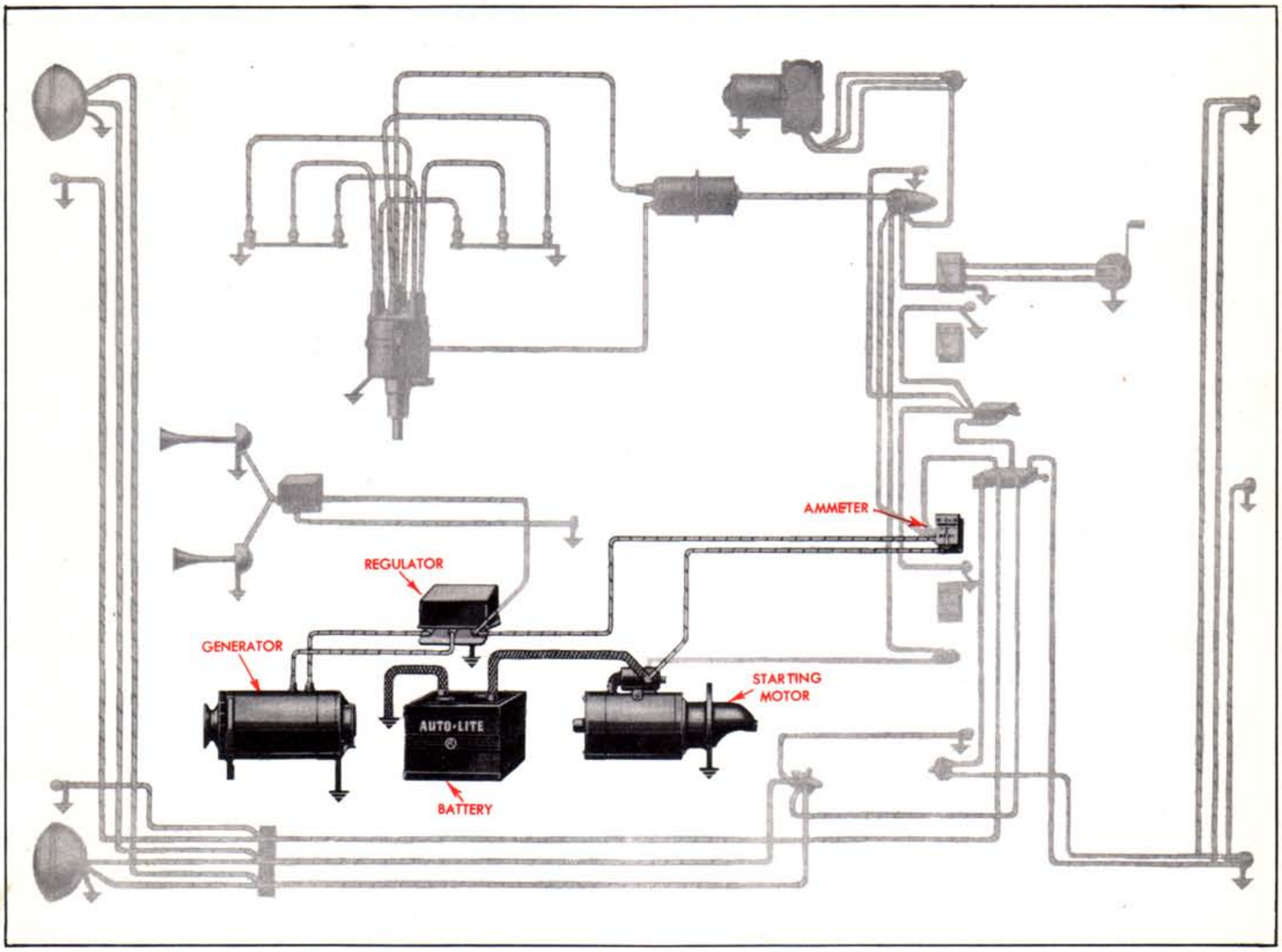


FIGURE 60—THE CHARGING CIRCUIT. This illustration is taken from the complete car wiring diagram shown in figure 1. All of the units or wires entering into the charging circuit are printed in full intensity while those which do not affect the charging circuit are subdued.

This illustration shows a separately mounted current and voltage regulator. If the regulator is mounted on the generator, the leads between the generator and regulator are very short and would not show in this type illustration. If a cut-out relay is used instead of the regulator, the field circuit is complete within the generator and there is only one lead between the generator and relay.

CHAPTER 3. THE CHARGING CIRCUIT

The charging circuit (Figure 60) consists of the generator, regulator, ammeter, battery and the necessary wires for connecting these units. The battery ground strap and chassis form the return circuit on most installations although some are designed for a two wire system and use a second wire for the return circuit.

The generator supplies all of the electricity needed by the various electrical devices on the car or engine. It produces electricity whenever the engine is running fast enough to make the generator operate. The battery stores the electricity in chemical form for use when the engine is not running and the regulator limits the voltage and current output of the generator.

THE BATTERY

While the primary purpose of the battery is to provide power to operate the starting motor it also forms a vital part of the charging circuit. It acts as a ballast tank on the charging system and helps to hold the generator voltage at the correct level, in fact on systems using a plain third brush generator, the battery is the only voltage control. The storage battery performs this function because its voltage is constant except for the variations caused by either a charging or discharging current. However, it does not hold the voltage within close limits and, when a high output generator is used, a separate control must be provided.

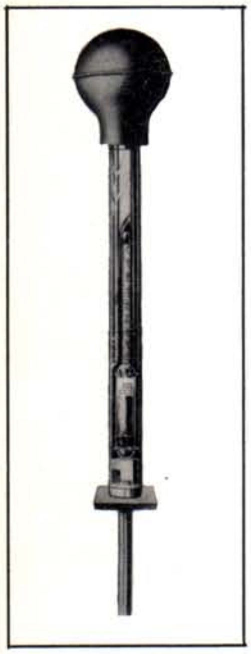


FIGURE 61—BATTERY HYDROMETER. This type hydrometer is recommended for making specific gravity readings of the battery electrolyte. Many hydrometers similar to the one illustrated have a built-in thermometer so that the actual electrolyte temperature can be read at the same time.

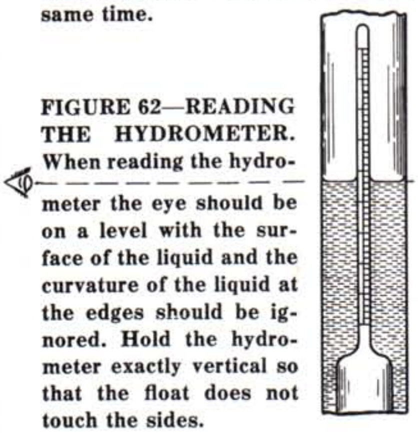


FIGURE 62—READING THE HYDROMETER. When reading the hydrometer the eye should be on a level with the surface of the liquid and the curvature of the liquid at the edges should be ignored. Hold the hydrometer exactly vertical so that the float does not touch the sides.

As the battery is primarily a part of the starting system it was described in Chapter 2. Battery Maintenance, however, is more dependent upon the charging system and, except for the high rate discharge test, should be inspected and maintained as a part of the charging circuit. The generator replaces the electricity taken from the battery during starting or by the parking lights. If the starting or other load is excessive or if the charging current is too low, the battery will become discharged; while if the charging rate is too high the battery will become overcharged and the high voltage developed under this condition will have a detrimental effect on the battery, lights, ignition contacts and the other parts of the electrical system.

BATTERY MAINTENANCE

There are two important things that must be periodically done in order to obtain long life from a battery.

First, the electrolyte must at all times be kept above the plates and separators. The liquid level should be brought to the level specified for each type. Only pure distilled water or water that has been approved for battery use should be added to a battery to replace that lost by evaporation. *Never add acid* except when it is definitely known that acid has been lost by spillage, then only by an experienced battery man.

Secondly, be sure that the battery is kept nearly charged at all times. The state of charge should be checked at frequent intervals by making specific gravity readings with a battery hydrometer (Figures 61, 62, 63, and 64). It is suggested that gravity readings and replacements of evaporated water be made every two weeks. Should the gravity fall more than .040 Sp. Gr. below fully charged gravity, remove the battery and have it charged.

The actual reading of a hydrometer will vary with temperature variations of the electrolyte. (An ordinary Dairy type thermometer may be used to take electrolyte temperature readings. Always take these readings from the center cell.) A hydrometer reading of a cell with electrolyte temperature above 80° F. will indicate less than the reading with the electrolyte at 80° F. The opposite holds true where the electrolyte temperature is below 80° F. Hydrometer floats are calibrated to indicate a correct reading only at one temperature, 80° F.

Expansion and contraction of the electrolyte due to temperature changes necessitates the application of corrections in order to arrive at the true specific gravity of the electrolyte. Figure 65 shows the correction which must be made in the reading obtained to reduce it to the standard temperature.

Excessive water evaporation (decomposition) from all cells of a battery indicates overcharging or excessive heat.

Check the generator and regulator operation according to the

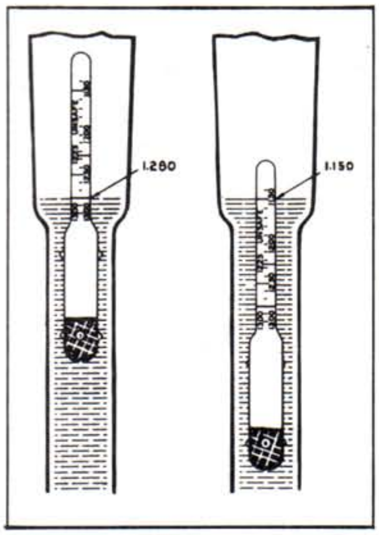
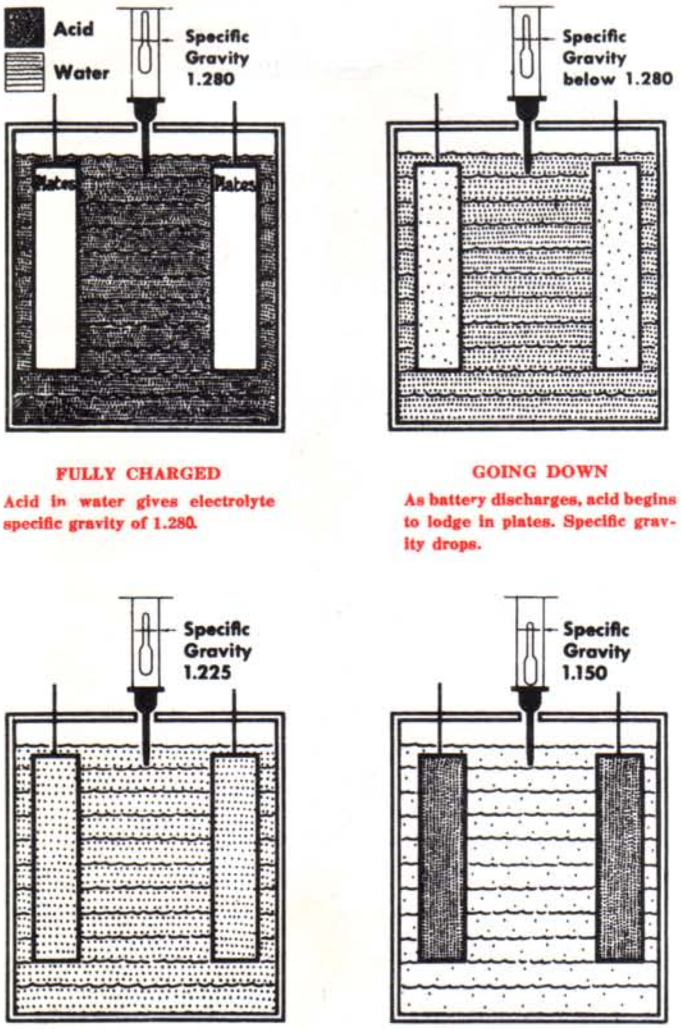


FIGURE 63—HYDROMETER READINGS. When the specific gravity is high the liquid is heavier and the float is at a high level as shown at the left. When the battery becomes discharged the acid leaves the electrolyte and the float sinks lower into the liquid as shown at the right.

instructions in other parts of this chapter. If the overcharging occurs on a third brush system, with or without a two charge regulator, it may be necessary to reduce the charging rate by adjusting the third brush.



FULLY CHARGED
Acid in water gives electrolyte specific gravity of 1.280.

GOING DOWN
As battery discharges, acid begins to lodge in plates. Specific gravity drops.

UNSAFE!
Battery half discharged. More acid in plates, less in electrolyte. Starting failure in sight if battery is allowed to remain in car.

DISCHARGED
Acid almost entirely in plates, leaving weak electrolyte behind. Specific gravity lower, almost that of water.

FIGURE 64—DIAGRAM OF A BATTERY'S STATE OF CHARGE. As a battery becomes discharged the acid leaves the electrolyte and combines with the plates leaving a weaker solution for the electrolyte and changing both plates to lead sulphate.

It is more desirable for a battery to show consistant, periodic gravity readings of between 1.260 to 1.280 than to always show 1.285 and higher (1.235 to 1.255 specific gravity for the Sta-Ful battery). One knows then that the battery is neither being overcharged nor undercharged. Several harmful effects result in charging a battery in excess of its requirements. These follow:

1. Decomposes water of electrolyte into hydrogen and oxygen gases. Gas bubbles tend to wash active material from the plates and carry moisture and acid from the cells as a fine mist.

2. Decomposition of water leaves acid more concentrated. Concentrated acid is harmful to wood separators and negative plate material at high temperatures over a prolonged period of time. The separators become charred and the negative plate material becomes granular.

3. High internal heat is created, which accelerates oxidation of positive plate grids and damages separators and negative plates. Also, containers may be softened and distorted and sealing compound displaced.

4. Overcharging alone or in combination with previous condition of undercharging may cause buckling and warping of positive plates, thereby perforating or pinching through the wood separators and touching the negative plates resulting in internal "shorts".

5. May cause damage by corrosion to cradle, cables and other vital electrical and engine parts by forcing the electrolyte from the cells. See figure 66.

Some bad effects can also be created even though the battery is not being overcharged, strictly speaking. Excessive demands upon the battery because of a faulty starter, poor connections, electrical shorts or leaks or more than normal use of electrical equipment will mean prolonged high charging rates, assuming the voltage regulator is functioning properly. The plates and separators assume the characteristics of overcharging, and shortened battery life follows from this hard use.

Excessive use of electrical equipment or insufficient input to the battery because of low voltage regulator setting, faulty

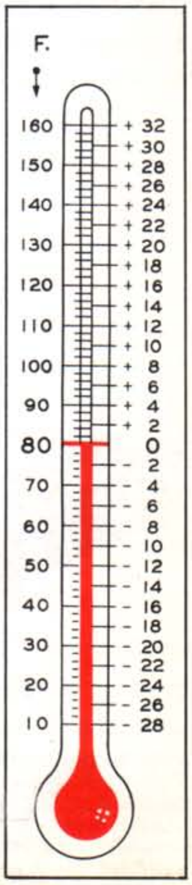


FIGURE 65—TEMPERATURE CORRECTION CHART FOR SPECIFIC GRAVITY READINGS. To reduce the reading obtained with the battery hydrometer to the standard temperature of 80° Fahrenheit, make the correction indicated opposite the actual temperature of the electrolyte.

generator, corroded terminals or insufficient time of charging will result in a starved or undercharged battery. Operated in this condition over a period of time may permit a type of sulphate to develop in the plates which is hard and crystalline. These crystals cannot be easily decomposed and electrochemically converted to active material again. Difference of density between crystalline areas and the normal active material of the positive plates induces strains so that distortion or buckling may result. Buckling will be accelerated when a sulphated battery is subjected to prolonged overcharging, either while undergoing a bench recharge or while in the car such as on an extended trip, or should the voltage regulator and/or generator be out of adjustment. As previously mentioned, buckled plates will pinch through wood separators and cause internal "shorts".

A battery operated in an undercharged condition will not only be unable to deliver full power, it is also liable to freeze during severe winter weather. The freezing point of the electrolyte varies with specific gravity variations. A fully charged battery with 1.285 Sp. Gr. corrected to 80° F. will freeze at -90° F. The following chart indicates the freezing points at various gravity readings:

Specific Gravity (Corrected to 80° F.)	Freezing Point of Battery
1.285	- 90° F.
1.250	- 62° F.
1.200	- 16° F.
1.150	5° F.
1.100	19° F.

Keep batteries charged in cold weather.

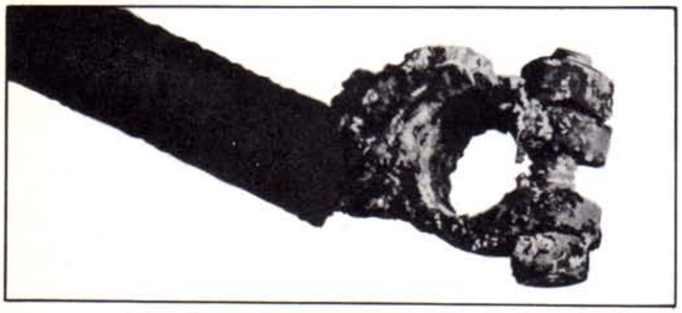


FIGURE 66—CORRODED BATTERY TERMINAL CLAMP. This illustration shows the effect of battery acid on the brass cable clamp. The corrosion causes poor contact between the cable and battery which reduces the efficiency of the electrical system. Eventually the cable or clamp becomes so weakened that it breaks entirely.

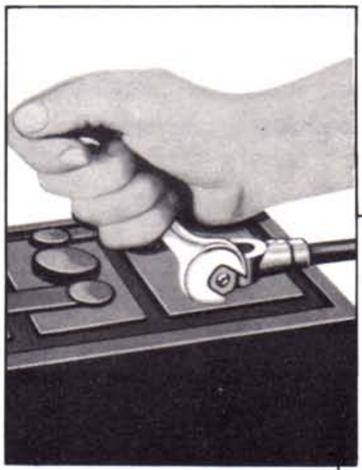


FIGURE 67—LOOSENING BATTERY TERMINAL CLAMP SCREW. It is recommended that an open end or socket wrench of the correct size be used. Do not use pliers.

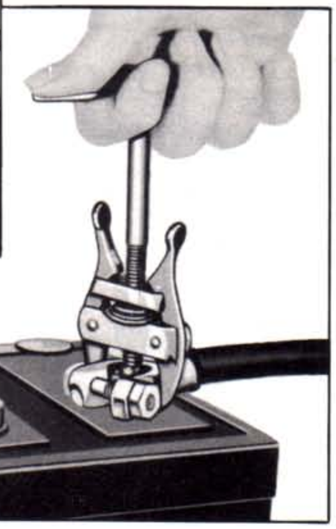


FIGURE 68—REMOVING CLAMP FROM BATTERY TERMINAL. Use a screw type puller as illustrated. Do not pry with screw drivers as this may damage the terminal, clamp or battery case and cover.

INSTALLING NEW BATTERY

1. Select new battery of electrical capacity equal to that placed in the car by the manufacturer. Use a larger capacity battery if the car has added electrical equipment that will be used when the engine is not running.

2. Note location of the positive terminal of the old battery. Disconnect "ground" terminal first. Loosen cable clamp terminal nuts and remove clamp terminal with a screw type terminal puller. See figures 67 and 68.

3. Inspect cradle and hold-downs for acid damage. Replace if necessary. Otherwise wash with soda water and stiff brush. Rinse, dry and paint corroded parts with black acid-proof paint.

4. Check cables for worn or frayed insulation. Replace terminal or bolts if corroded. See figure 66.

5. Clean and tighten the ground connection to the frame. Tighten switch and starter connections.

6. Be sure battery is fully charged.

7. Place battery in cradle. See that it rests level. Tighten hold-down nuts evenly at each point until battery is secure. Hold-down nuts, too tight, will cause distortion and damage to battery container.

8. Make sure that cables are long enough to cause no strain on posts and covers. Clean battery terminals and inside of clamp terminals with sandpaper or wire brush. This is very important as a poor contact causes low current in a voltage regulated system and high voltage in a third brush system. Apply mineral grease to posts and inside of clamps.

9. Check polarity. Slip cable clamps over posts temporarily and turn on light switch. Ammeter should read "discharge" or move to the minus (–) side of the meter.

10. Remove ground cable and connect it last. Arrange cable clamps so as not to interfere with removal of vent plugs and arrange cables so that they will not rub on hold-down clamp or moving parts, then tighten.

11. Check charging rates. A fully charged battery and a low charging rate, after engine has been running a few minutes, is normal. If the charging rate is too high or too low check the wiring, generator, and regulator as described in this chapter.

THE CHARGING CIRCUIT WIRING

The wires in the charging circuit connect the generator, regulator, ammeter or signal light and battery. They must have sufficient capacity to carry the full generator output without excessive voltage loss due to resistance. The insulation should be able to withstand the effects of water, oil and weather without rapid deterioration which would cause brittleness or fraying. The wires and connections should not be readily broken or loosened by vibration.

The chassis and frame form the return or ground circuit on most charging circuits although some are designed for a two wire system and use an insulated wire for the return side. This ground circuit should not be overlooked when dealing with the generating system as many of the charging circuit troubles can be traced to faulty or high resistance ground connections. In fact, high resistance in the charging circuit is the principle cause of high voltage, burned out lamps or burned ignition contacts on some systems and of run down batteries on other types of systems.

Original wiring is determined on a basis of not more than .2 volt loss between the units in the charging system when operating at full capacity. The size of the wire, therefore, depends upon the overall length of the circuit and on the maximum generator output. On this basis, charging circuits with very short leads could use extremely small wire; however, due to the increased factor of the resistance in the connections and also to the desire for adequate mechanical strength, wire size is proportionately larger.

When a larger capacity generator is installed on an engine it is extremely important that the wiring capacity be checked according to the voltage drop test which follows. If the wiring does not have sufficient capacity either install new leads of larger size or parallel the leads with a second set.

WIRING MAINTENANCE

The wiring between generator, regulator, ammeter and battery should be periodically inspected for loose connections, breaks (especially where the wires are clamped by the terminals), frayed or damaged insulation and for corrosion. Clean, repair or replace any defective wiring.

Inspect the battery ground strap, generator mounting, and regulator ground connection to make sure all are tight and free from corrosion. See figure 66. If necessary, remove the regulator and generator mounting screws and the battery cables and clean the mounting faces on each unit and on the engine or frame. Be sure to thoroughly tighten the mounting and ground screws.

On some installations the cutout relay or regulator is mounted on the generator. On this type it is necessary to remove the relay or regulator mounting screws and lift the unit from the generator in order to make the above inspection of the leads and mounting.

Disconnect the lead from the cutout relay or regulator "Battery" terminal and connect an ammeter between the terminal and lead. Operate the generator at a medium speed and turn on the lights or accessories to give ½ the maximum generator charging rate. With a low reading voltmeter measure the voltage drop between the following points:

SEPARATELY MOUNTED REGULATOR OR CUTOUT RELAY

1. Generator "A" terminal to battery terminal —.6 volt maximum.
    a. Generator "A" terminal to regulator "A" terminal—.15 volt maximum.
    b. Regulator "A" terminal to regulator "B" terminal—.2 volt maximum.
    c. Regulator "B" terminal to ammeter terminal—.15 volt maximum.
    d. Across the two ammeter terminals.—.05 volt maximum.
    e. Ammeter terminal to battery post—.15 volt maximum.
2. Generator "F" terminal to regulator "F" terminal —.05 volt maximum.
3. Generator frame to battery ground post —.04 volt maximum.
    a. Generator frame to car frame—.02 volt maximum.
    b. Battery post to car frame—.02 volt maximum.
4. Generator frame to regulator base —.04 volt maximum.
    a. Generator frame to car frame—.02 volt maximum.
    b. Regulator base to car frame—.02 volt maximum.
5. For two wire systems only (In addition to 1 and 2 above).
    a. Generator "Return" terminal to battery terminal—.1 volt maximum.
    b. Generator "Return" terminal to regulator return terminal —.1 volt maximum.
    c. Regulator "Return" terminal to battery terminal—.1 volt maximum.

REGULATOR OR CUT-OUT RELAY MOUNTED ON GENERATOR

1. Regulator or Relay "B" terminal to battery terminal —.35 volt maximum.
    a. Regulator "B" terminal to ammeter—.15 volt maximum.
    b. Across the two ammeter terminals—.05 volt maximum.
    c. Ammeter terminal to battery post—.15 volt maximum.
2. Regulator base to generator frame —.01 volt maximum.
3. Generator frame to battery ground post —.04 volt maximum.
    a. Generator frame to car frame—.02 volt maximum.
    b. Battery ground post to car frame—.02 volt maximum.

If the voltage drop for any of the major or overall tests above is greater than the maximum specified, the drop should be checked over each part as specified to locate the cause of the excessive drop. If a connection is at fault, the terminals should be carefully cleaned and inspected and the wire should be inspected for partial breaks. If no apparent cause can be detected replace the wire with one of larger size. If the voltage loss in the regulator or ammeter is more than the maximum specified consult other parts of this manual for the proper inspection and repair procedure on these units.

	Total Length of Load Circuit in Feet																		
Generator Capacity	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**60**	**75**	**100**
15 Amps.	13	13	13	12	11	10	9	9	8	8	7	6	6	5	5	4	3	3	1
25 Amps.	11	11	11	10	9	8	7	7	6	6	5	4	4	3	3	2	1	1	00
35 Amps.	10	10	10	8	7	7	6	5	5	4	4	3	2	2	1	0	0	00	000
45 Amps.	9	9	8	7	6	6	5	4	4	3	2	2	1	0	0	00	00	000	—
55 Amps.	8	8	7	6	5	5	4	4	3	3	2	1	0	0	00	00	000	—	—
65 Amps.	8	8	7	6	4	4	3	3	2	2	1	0	00	00	000	000	—	—	—
75 Amps.	6	6	6	5	4	3	3	2	2	1	0	0	00	000	000	—	—	—	—

FIGURE 69 WIRE SIZES RECOMMENDED FOR GENERATOR LOAD CIRCUIT.

To use this table measure the length of the generator to regulator, regulator to ammeter and ammeter to battery wires (also the length of return circuit on two wire systems). Add these lengths and find the total in the figures at the top of the columns. Follow the column down to the line corresponding to the maximum generator output and read the figure where these lines cross which will be the recommended size for the above leads.

	Total Length of Field or Regulator Ground Wire																				
	2	4	5	8	10	12	14	16	18	20	25	30	35	40	45	50	55	60	65	70	75
Field Lead	16	16	16	15	14	14	13	13	12	12	11	11	10	10	10	9	9	9	8	8	8
Ground Lead	16	16	16	15	14	14	13	13	12	12	11	11	10	10	10	9	9	9	8	8	8

FIGURE 70 WIRE SIZES RECOMMENDED FOR GENERATOR FIELD OR GROUND CIRCUIT.

To use this table measure the length of the wire from the generator "F" terminal to the regulator "F" terminal or to the light switch when the control is incorporated in the switch. Read the proper wire size corresponding to that length. (Note—See Figure 69 for return circuit on two wire systems).

When installing new wires in the charging circuit be sure they have sufficient capacity to carry all of the generator output and have waterproof and abrasion resistant insulation. Install metal terminals of the correct size for the wire and screws,making sure they are clamped and soldered to reduce resistance and to make strong mechanical connections. Clamp or bind the leads to the frame or some other part of the chassis to prevent vibration of the wires which may cause breaks. Avoid sharp bends and always use an insulating grommet when running the wires through a hole in the sheet metal.

Figure 69 gives the recommended size of wire to be used in the generator load circuit. The wire size is given for each combination of generator output and length of the leads. Figure 70 gives the same information for the field circuit.

When a ground lead is installed between the generator and regulator it should be in the same size as the field lead; however, on two wire systems,the return circuit carries all of the generator output and the wire size should be the same as that recommended for the load, or battery circuit.

THE GENERATOR

On the first gasoline engines there were not many electrical devices and the generator had only a small capacity. As additional electrical equipment was added it was necessary to increase the capacity of the generator to take care of the increased load. While the battery capacity has increased only slightly to take care of the starting and parking light load, the generator capacity has increased from approximately 10 amperes on the early engines to 40 or more amperes on many of the present cars and trucks. Higher output generators are now being built for use on special applications having two way radio or other equipment requiring a large electrical capacity.

Both the 10 ampere generator and the high output generator operate on the same principle; the only difference being in the design and the method of output regulation. The basic principle of generation is that a voltage is produced whenever an electrical conductor is moved across a magnetic field. In operation this is accomplished by rotating a loop of wire about an axis centered between two magnetic poles. In order to increase the amount of electricity, the loop usually has more than one turn and a number of loops are connected in series. These conductor loops are mounted on a framework of iron with a shaft which supports this armature assembly in bearings mounted at each end of the generator. See figures 71 and 72. Some of the electric current produced by the generator flows back through coils of wire which produce the magnetic field necessary to generate electricity. Soft iron pole shoes, armature core and frame form a low magnetic reluctance circuit for the magnetic field and channel the field through the place where the conductors in the armature will pass.

Due to the rotating action of the armature, the conductors cut through the magnetic field first in one direction then the other. This produces an alternating current in the conductors. A commutator consisting of a number of copper segments insulated from each other and from the armature core and shaft, together with the brushes, acts as a rotating switch to reverse the connections of each coil as the generated voltage reverses in each revolution. This results in a direct current which is carried away by the brushes.

The voltage produced by a generator depends upon the number and connections of the armature conductors, the strength of the magnetic field and the speed at which the conductors cut through the field. The connections and conductors in the armature are fixed by the designing engineer. The strength of the magnetic field depends on the design of the magnetic path for the field and on the number of ampere-turns in the field windings. The speed at which the conductors move through the field is dependent upon the generator operating speed. The only one of these conditions which can be controlled after a generator has been built and installed, is the number of ampere-turns in the field windings. This is done by varying the current flowing through the windings by means of various regulating devices.

GENERATOR CONTROLS

A number of methods are used to vary the field current and control the generator output. Many of the lower output units use a third brush which makes use of the magnetic field produced by the armature windings to reduce the voltage applied to the field coils as the speed is increased.

The third brush is placed between the main brushes so that not all of the armature coils are included between the third brush and grounded main brush. This gives only a percentage of the full generator voltage which is applied to the field coil windings. As the generator speed increases, the current in the armature winding creates a

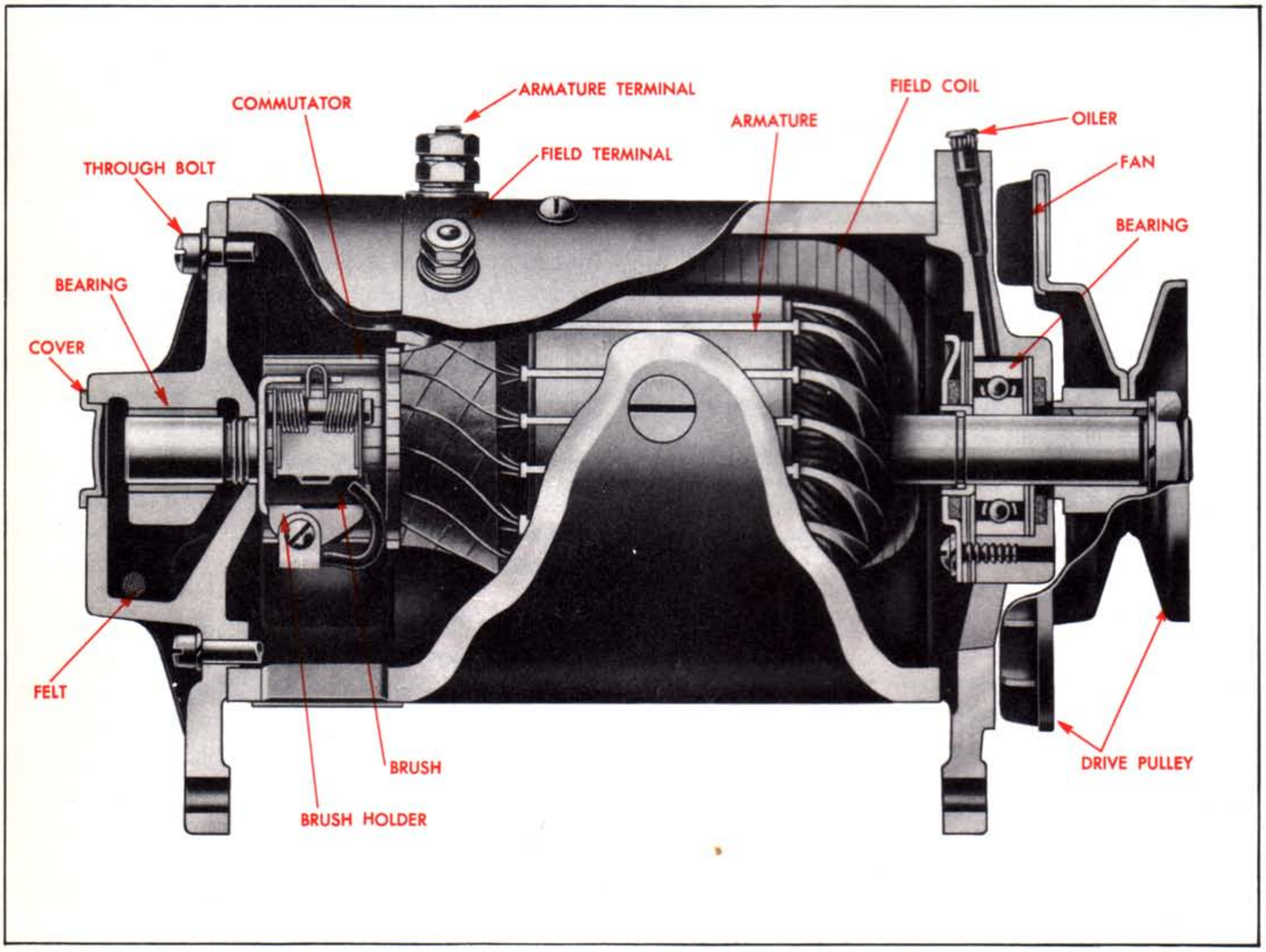


FIGURE 71—SECTIONAL VIEW OF A GENERATOR. This is a popular type generator using a ball bearing at the drive end and a bronze bearing at the commutator end. The regulator is mounted separately from the generator and is connected to the armature and field terminals extending through the top of the frame. Ventilation is provided by means of the centrifugal fan combined with the drive pulley.

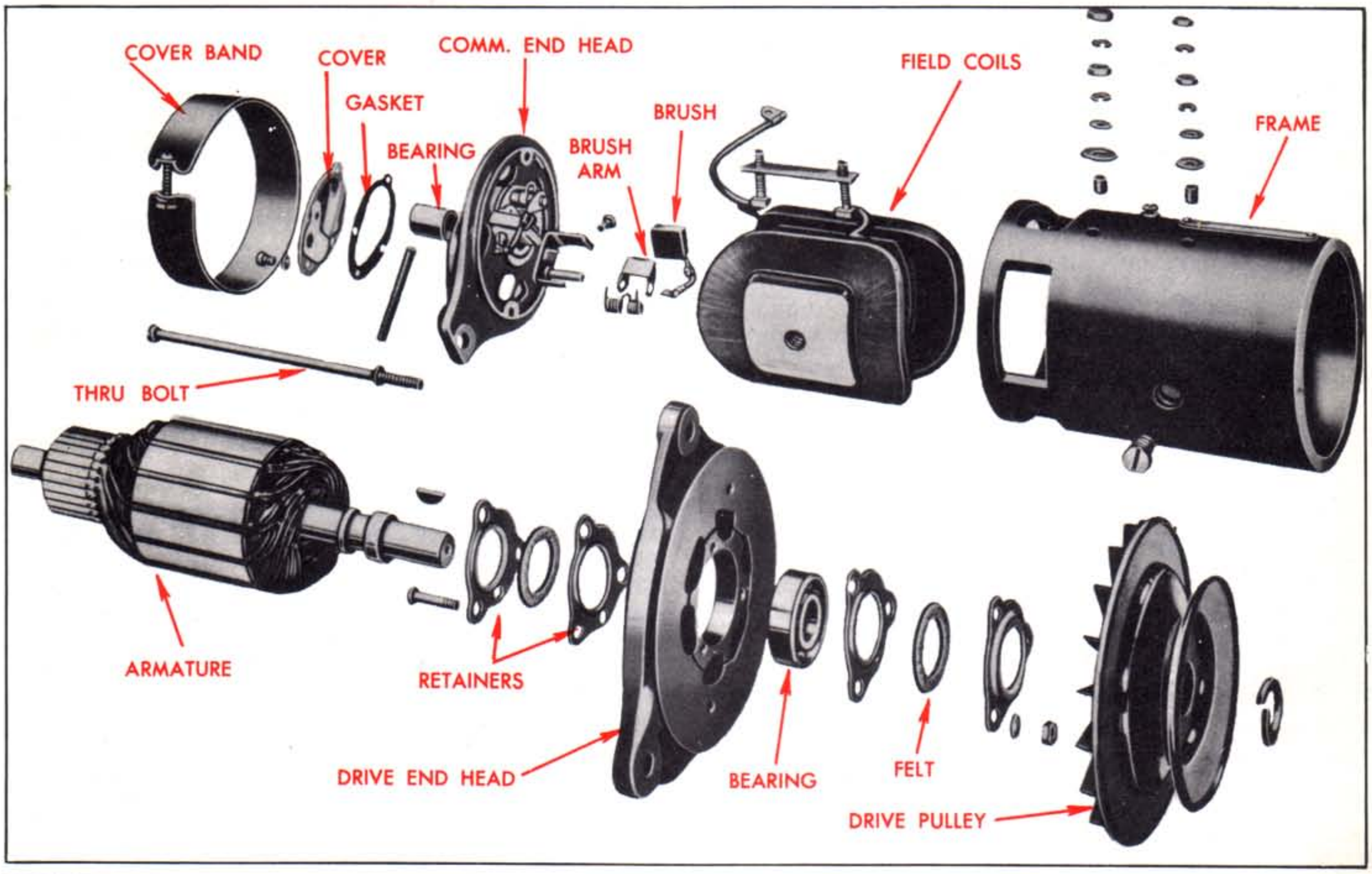


FIGURE 72—EXPLODED VIEW OF A GENERATOR. This generator is similar to that shown in figure 71 and shows the various parts disassembled. Each part is shown in its correct relation to the others in this "exploded" view.

magnetic field which combines with the stationary field to reduce the field strength on the leading edge of the poles. This is the same effect as if the field were pushed slightly by the rotating armature. The amount of this shift in the field depends on the speed of the armature and on the current flowing.

Since the span included between the grounded main brush and the third brush includes those coils under the leading edge of the poles, the reduced magnetic field causes a reduced third brush voltage and therefore a reduced field strength. The resulting output curve is typical of the upper curve shown in figure 73. Low output generators with third brush control can be used where the requirements of the circuit are not large and are comparatively steady. If no other regulation is used with high output third brush generators,there is danger of overcharging the battery when the maximum output is not needed, with a resultant damage to the battery, ignition contacts and lamps caused by the high voltage generated under these conditions.

With high output units and on those installations where a close control is needed, a separate regulator is used. This regulator controls the output by connecting a resistor in the field circuit under certain conditions. The regulator may be of the two charge type which is used with third brush generators and gives a high or low charging rate as shown in figure 73, depending on the generator voltage. Vibrating type voltage regulators are used with either third brush or shunt type (no third brush) generators and hold the voltage within close limits. A typical output curve of a third brush generator with a vibrating type voltage regulator is shown in figure 74. Shunt type generators have no inherent control of the output and must have a current regulator to limit the maximum output to a safe value. This current regulator is used in addition to a regulator which controls the generator voltage and gives an output curve similar to that in figure 75.

All generators used with the conventional storage battery system have a cutout relay connected between the generator and battery. This cutout acts as an automatic switch which connects the generator to the battery when the generator is revolving fast enough to charge, and opens to prevent the battery from discharging back through a slowed or stopped generator. This relay may be used alone on a plain third brush generator or it may be combined on the same base with a two charge regulator, vibrating voltage regulator or with a vibrating current and voltage regulator.

Regulating devices used with automotive type generators control the voltage produced and the current depends upon the battery condition and amount of load connected to the generator. Third brush generators do not have a close control of the output and the voltage produced under some conditions may rise to a high value. The armature reaction used by these generators to control the output varies with the speed and load conditions. High voltage in the circuit increases the field strength and causes a larger generator output. These increases tend to accumulate and, when the battery is fully charged and there is no connected load, or if there is high resistance between the generator and battery the voltage may rise to an excessive value.

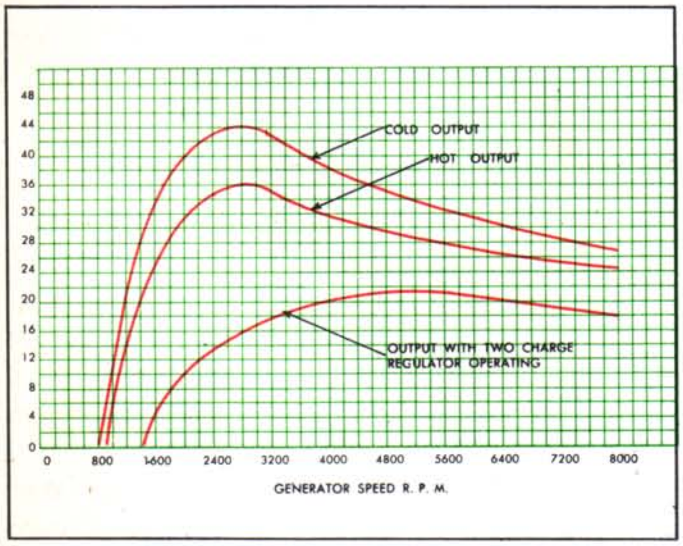


FIGURE 73—OUTPUT CHARACTERISTICS OF A THIRD BRUSH GENERATOR. The three curves in this graph show the generator output of one type third brush generator at the various speeds and for three conditions. The upper curve shows the output of a cold generator (80° F.) with the field grounded directly. The center curve shows the generator output after it has been warmed by continued operation while the lower curve shows the output of the generator when the two charge regulator has inserted resistance into the field circuit.

The output figures in this illustration apply only to the GDS type generators; however, other third brush units have the same general characteristics.

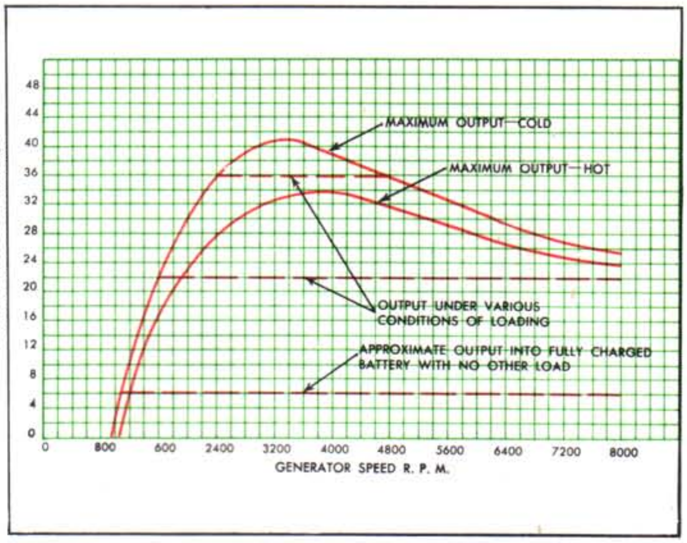


FIGURE 74—OUTPUT CHARACTERISTICS OF A THIRD BRUSH GENERATOR WITH A VIBRATING VOLTAGE REGULATOR. When comparing this illustration with figure 73 it will be noted that the maximum output above has the same general characteristics as the cold and hot output curves in figure 73. The difference is in the effect of the regulator on the generator output. In figure 73 only one curve depicts the output when the regulator is operating, while in this illustration the regulator reduces the maximum output to that required by the battery and connected load and may be any figure between the minimum and maximum noted.

This illustration shows only the output of a GEC type generator; however, the output curves of other third brush units using a vibrating type voltage regulator have the same general shape, but differ in speed and amperage figures.

The voltage regulator limits the generator voltage to a specified value and the amount of current depends on the circuit. If there is high resistance the current will be small, while if the external circuit has low resistance (low battery or high connected load) the current will rise to make the voltage across the load equal to the generated voltage. The current regulator limits the generator output to its maximum safe value by controlling the generated voltage at a value that will give the specified current through the external load.

If there is a loose connection in the charging circuit, the voltage of a third brush generator may rise excessively and cause burned out lamp bulbs or ignition contacts; while if the high resistance occurs in a voltage regulated system, the voltage remains constant at the limited value and the current is reduced by the resistance, resulting in a rundown battery.

GENERATOR DESIGNS

Generators are built in many voltages and designs to fit the special requirements of the application for which they are intended. Some generators are completely enclosed to exclude moisture and dust. Others are ventilated by a suction fan usually combined with the drive pulley. A typical ventilated generator is illustrated in Figure 76. The air stream passing over the armature and field coils carries away the heat and allows a much higher output without the danger of burning out the armature or fields. Ventilated generators are used on most automotive and truck applications while nonventilated generators are used on marine or tractor applications where dust or moisture is likely to cause damage.

Many styles of mounting and methods of drive are used depending upon the particular applications for which the generator is intended. The hinge type mounting with a belt drive is most common on cars, light trucks and many marine and tractor engines. Other units are often flange or base mounted and may use either a belt or gear drive. Some installations use a coupling drive and may drive a water pump or other apparatus with a coupling connected to an extension on the commutator end of the armature shaft.

Internal generator construction varies as to mechanical differences and also in the type and size of the windings. Different combinations of wire size and number of turns in the armature and field windings give various characteristics of cut-in speed, maximum output and are suitable for different methods of regulation. Generators designed for use with vibrating type regulators have a low field current draw to keep the current in the regulator contacts as low as possible. Third brush generators usually have a higher field current to increase the field strength without increasing the size of the coils.

One limiting factor in determining the maximum output of a generator is the temperature developed on the insulation and soldered connections. The high output generators use larger wire and may have special heat resisting insulation. Low cut-in generators have more turns in the armature and field windings. This increases the internal resistance and reduces the maximum output obtainable without overheating the generator.

GENERATOR APPLICATION

The type and amount of load, maximum speed, usual operating speed, cut-in speed and operating conditions are all considered by the equipment engineer when recommending a generator for a particular application.

Third brush generators are suitable for use on constant speed applications such as stationary power plants, boats or tractors where the current requirements are constant and of low value. The drive pulley or gear is selected to give a usual operating speed at or just above the peak output speed of the generator.

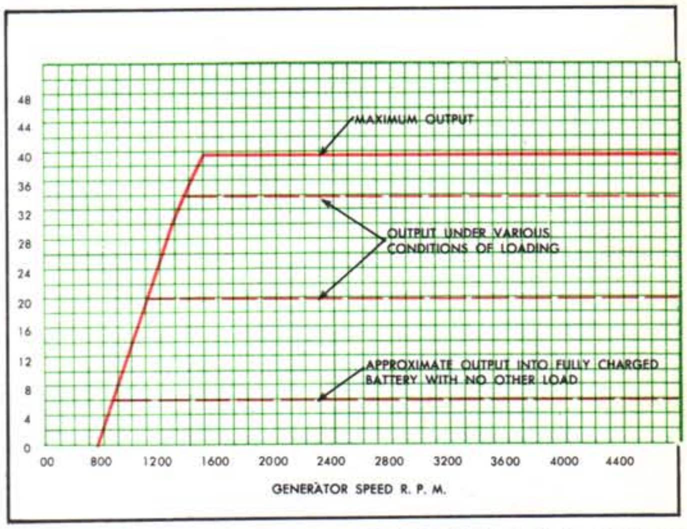


FIGURE 75—OUTPUT CHARACTERISTICS OF A SHUNT TYPE GENERATOR WITH A VIBRATING CURRENT AND VOLTAGE REGULATOR. Note that on this type generator the output quickly reaches its maximum value as the generator speed is increased and there is no reduction in output at high speeds. The current regulator limits the generator output at the maximum value indicated by the heavy horizontal line. The voltage regulator reduces the output below the maximum, to limit the voltage at a constant value and give an output in accordance with the circuit requirements.

On some tractors and marine installations or in cases where a higher output is needed for lights or other intermittant load, a two charge regulator can be used with the third brush generator. This enables the selection of a higher output generator to meet the maximum load conditions and still have low output when the extra load is not connected.

Where the speed and load conditions vary, but do not reach extremes of high and continued low speeds or where the maximum load is variable, a vibrating type voltage regulator may be used with a third brush generator. This regulator controls the output to conform closely to the requirements of the battery and connected load. The regulator holds the generator voltage constant under wide variations of loading and the charging rate varies to allow a high current when the battery is low or when a large load is being used. If the battery is fully charged and there is no accessory load, the regulator holds the generator output to a low sustaining charge.

When the vibrating type regulator is used with a third brush generator there is no danger of overcharging the battery. The maximum current is still controlled by the third brush but the regulator limits the generated voltage to a safe value and reduces the generator output to that needed for the connected load. A typical output curve for a third brush generator with a vibrating voltage regulator is shown in figure 74. The heavy line indicates the maximum output obtainable, as controlled by the third brush, while the dotted lines indicate the output produced under various conditions of loading. On applications having wide variations of speed and load conditions, a shunt type generator with a vibrating type current and voltage regulator gives a charging rate that is fully dependent on the requirements of the circuit. The maximum output is obtainable at a comparatively low speed and there is no reduction in the maximum output at high speeds. See figure 75.

The generator drive ratio is selected to keep the maximum generator speed below the safe operating speed for that type generator and keep the operating speed low to prevent excessive wear of bearings and brushes.

GENERATOR MAINTENANCE

The generator should be periodically lubricated and inspected for external conditions which affect the generator operation. It is recommended that generator oilers be given 3 to 5 drops of medium engine oil at

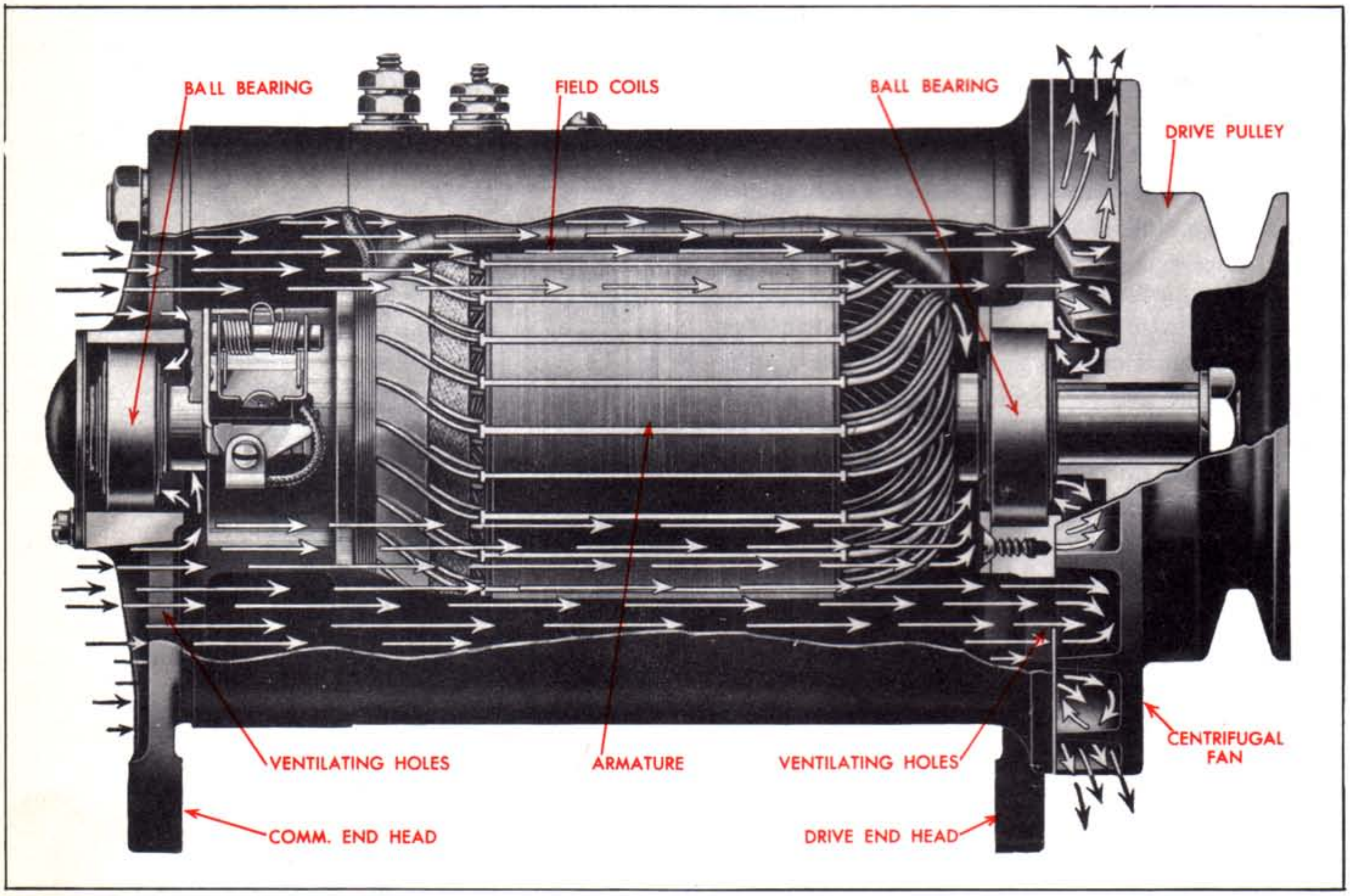


FIGURE 76—SECTIONAL VIEW OF A VENTILATED GENERATOR. Air is drawn in through the holes in the commutator end head and passes over and around the brushes, commutator, armature and fields. It is expelled by the centrifugal fan which is combined with the drive pulley.

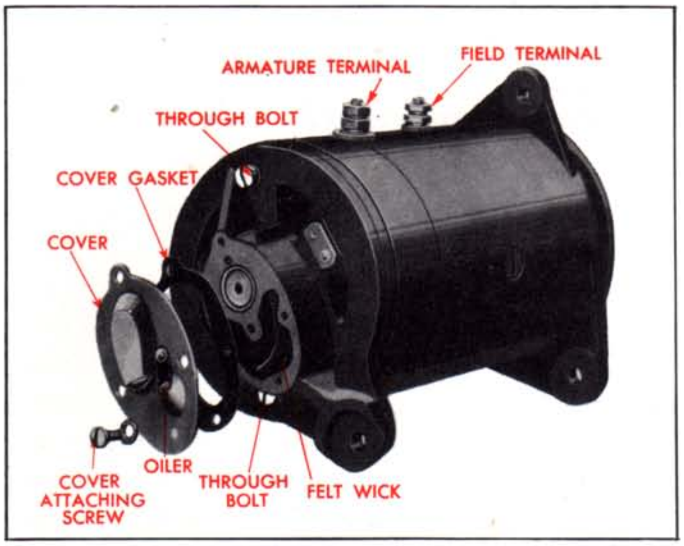


FIGURE 77—COMMUTATOR END OILER FOR A GENERATOR USING AN ABSORBENT BRONZE BEARING. A swinging cover over the hole can be moved aside when oil is being added. The overflow hole is located on the bottom of the offset and prevents over-lubrication.

regular chassis lubrication periods. Generators with an oil reservoir in the commutator end should have the oil pocket filled with medium oil. See figure 77.

At regular periods (5000 miles or 150 hours recommended) the outside of the generator should be wiped clean and both the ventilating holes and fan inspected for an accumulation of dirt which would obstruct the flow of air. The cover band should be removed and the commutator and brush holders inspected for excessive dirt and oil which may cause poor performance. The brushes should be inspected and if cracked, oil soaked, or worn to less than ½ their original length they should be replaced as outlined in the overhaul procedure. Usually it is only possible to inspect one brush when the generator is mounted on the engine, but the one brush is a fairly good indication of the others and will suffice for the 5,000 mile (150 hour) inspection. If the generator brush holders are dirty or if the commutator or brushes are worn,the generator should be removed for an overhaul.

Check the generator mounting for alignment and looseness and check the belt for wear and correct tension. Hook a spring scale under the belt midway between two pulleys and pull to give a 5 pound reading. The deflection of the belt should be about 1″, but the various engine manufacturers specifications should be obtained and followed exactly.

Check the charging circuit wiring every 5,000 miles (150 hours) and the regulator as outlined in this chapter.

The generator should be removed from the engine and overhauled at periodic intervals, or whenever the 5,000 mile inspection shows attention is needed. While the period between overhauls will vary depending upon the type of service it will under normal conditions be required every 25,000 to 50,000 miles (750 to 1,500 hours). Dirt, dust, water, and high speed operation cause more rapid wear of the brushes and bearings and necessitate more frequent reconditioning.

REMOVAL FROM ENGINE

Disconnect the leads from the generator terminals or from the regulator or cutout relay if this unit is mounted on the generator frame. Tape the battery lead to prevent its becoming grounded against the engine or frame. Remove the generator mounting bolts and lift the unit from the engine. On hinge type mountings it is usually easier to remove the adjusting strap bolt and swing the generator to expose the lower mounting bolts.

PRELIMINARY TESTS

Remove the generator cover band. Place the generator on the test bench and connect for a motoring test by connecting an ammeter and variable resistance in series between the armature lead or terminal and one battery terminal. Connect the second battery terminal to the generator frame and connect a voltmeter from the armature terminal or lead to the generator frame. Complete the field circuit by connecting the field lead or terminal to either the generator frame or the armature terminal depending upon the internal connections of the generator. All Auto-Lite third brush generators and most shunt type units have the external field terminal grounded by the regulator and must have the field terminal grounded to the generator frame to complete the field circuit. Generators using heavy duty regulators; however, have the field circuit grounded within the generator and must have the field and armature terminals connected together to complete the field circuit. See figures 78, 79, and 80.

With the generator connected as above it should operate as a motor with the armature turning slowly. Adjust the variable resistance to give the generator terminal voltage as specified for the motoring test on that particular type generator and read the ammeter. Also note the brush action while the generator is operating as a motor. The results of this test will indicate what conditions should be especially looked for during the overhaul.

LOW MOTORING CURRENT

Look for an open winding in the armature or for high resistance at the internal connections and in the brush contact on the commutator. An open armature can be detected because one spot on the commutator will be burned by the arc which is formed every time the open passes under a brush. The most likely causes of high resistance are worn brushes and dirty or worn commutator both of which can be located by visual inspection.

HIGH MOTORING CURRENT WITH ARMATURE NOT TURNING

This condition indicates that the field coils or armature may be grounded or shorted; that the brush position is incorrect due to the installation of the wrong head on the generator, or to the incorrect assembly of the generator. This condition may also be due to some restriction preventing the armature from rotating. Check this possibility by turning the armature by hand to make sure it turns easily with only a slight brush drag. If the armature does not turn easily it indicates

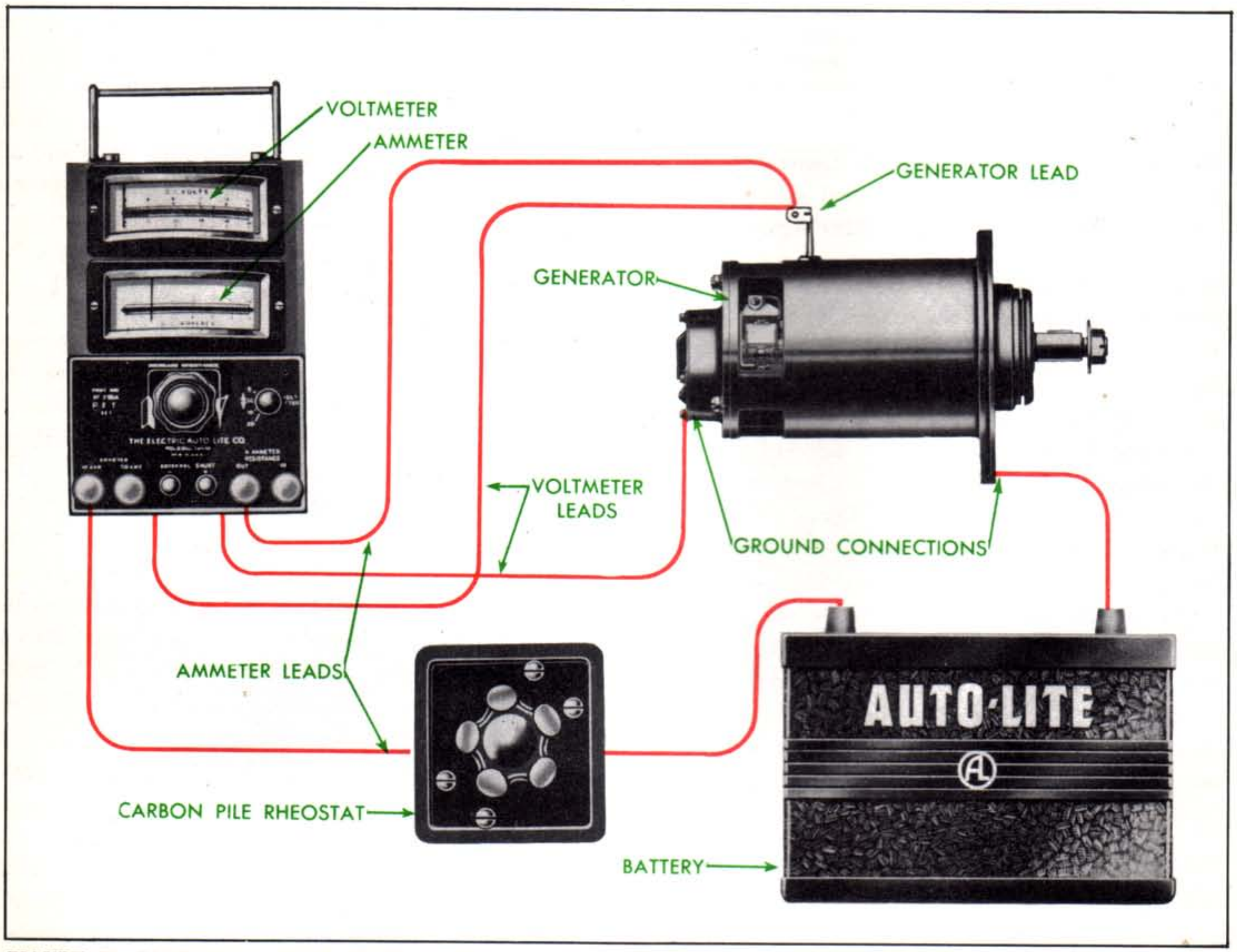


FIGURE 78—MOTORING DRAW TEST DIAGRAM—GENERATORS WITHOUT A FIELD TERMINAL OR LEAD. This is the hookup to be used when measuring the motoring current of third brush generators that do not have an external field circuit.

Connect the battery into the circuit last by first flashing the battery cable against the terminal to check for possible shorts and damage to the meters.

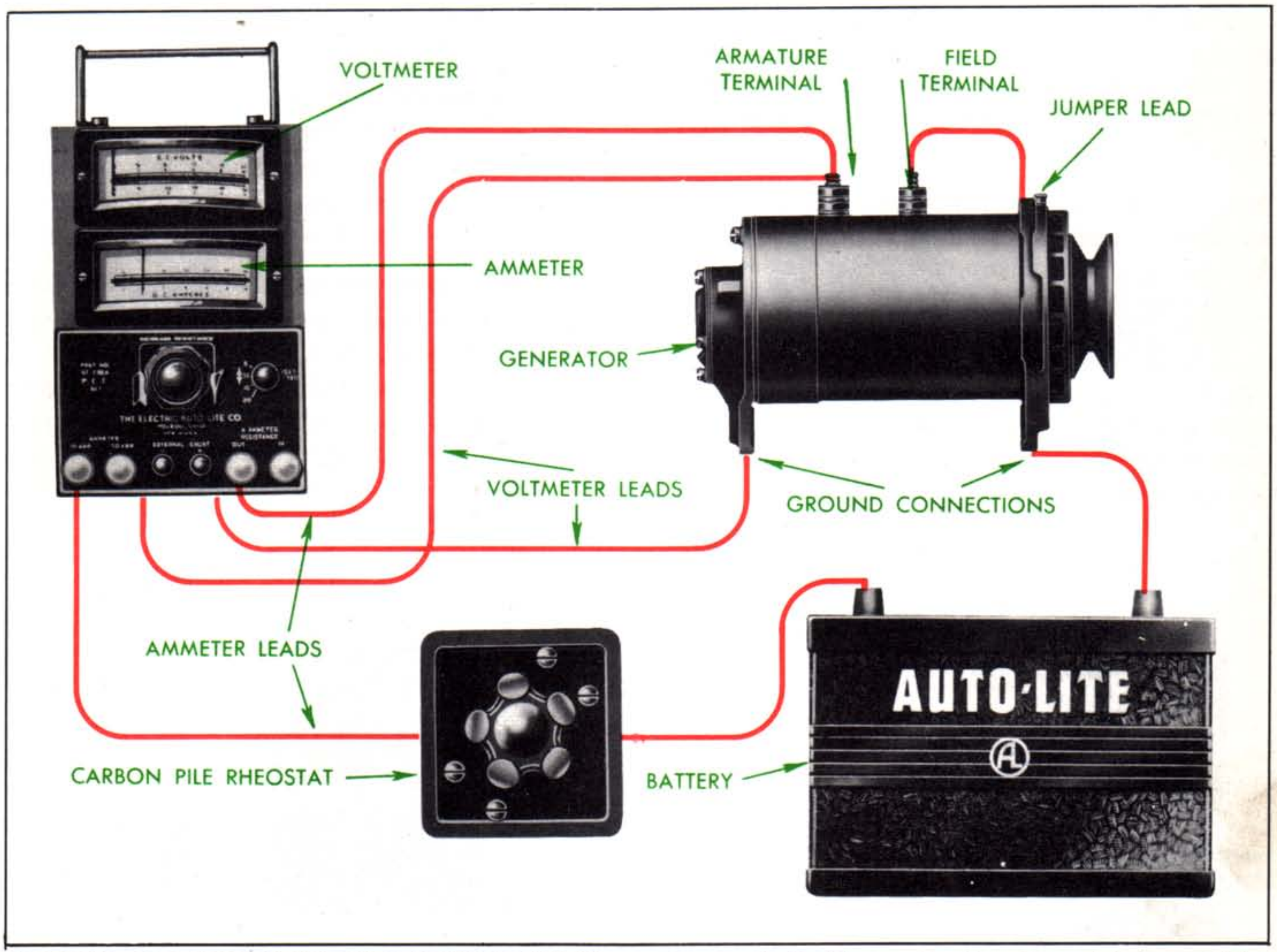


FIGURE 79—MOTORING DRAW TEST DIAGRAM—GENERATORS HAVING FIELD GROUNDED IN REGULATOR. This is the hookup to be used when measuring the motoring current of most Auto-Lite generators. These same connections are used for both third brush and shunt type units which have an external field circuit through the regulator. This hookup does not apply, however, to shunt type units using a heavy duty type regulator.

Connect the battery into the circuit last either by inserting a switch in the battery line or by flashing the cable against the battery terminal to check for shorts and possible damage to the meters.

worn or dirty bearings, faulty or excessively worn brushes, incorrect generator assembly which eliminates end play or to foreign matter rubbing on the armature or fan.

HIGH MOTORING CURRENT WITH ARMATURE TURNING

This is usally caused by excessive drag on the armature which may be due to worn or improperly lubricated bearings, improper end play, loose or misaligned bearings, brush tension too high, worn or rough commutator or to some other interference with armature movement.

EXCESSIVE BRUSH MOVEMENT OR ARCING

Check the armature for opens as noted above. Inspect the commutator for dirt, wear, and runout and check the brushes for wear, damage and proper tension.

Connect the generator as described above for the motoring test except remove the variable resistance from the circuit and add a load rheostat across the battery terminals. Connect the generator to the driving motor and operate in the specified direction of rotation. Increase the speed slowly and hold the voltage at the specified value by adjusting the load. On shunt type generators note the speed when the specified output is obtained; and, on third brush generators note the peak output as the speed increases. Adjust the third brush to give the specified output by placing a screwdriver against the base of the third brush holder stud and tapping lightly with the hand.

If the speed is higher than the specified value or if the specified output cannot be obtained, inspect for inadequate brush seating, high resistance and for faulty armature or fields. Also make sure that the brush position has been correctly set.

It is important that generator tests are made when the generator is at room temperature as heat increases the resistance of the windings and changes the operating characteristics. For this reason all specifications are given for a cool generator. In the rare occasion when the generator must be tested while hot, a higher speed must be allowed to obtain the maximum output of shunt generators and third brush generators must have the peak output set 3 or 4 amperes lower than that specified.

DISASSEMBLY (See figures 72, 81, and 82)

Disconnect the leads from the brush holders and if the brushes are the reaction type lift the brush arm with a hook. See figure 83. Pull brushes up slightly and place the end of the brush arm or spring against the side of the brush to hold it in place and prevent damage during the balance of the disassembly.

Some generators have a shaft screw in the commutator end to hold the commutator end ball bearing in place as shown in figure 84. On this type the commutator end cover must be removed and this screw taken out before the generator heads can be removed. Other units may have a fan or a distributor mounting housing on the commutator end as shown in figures 85 and 86. Through

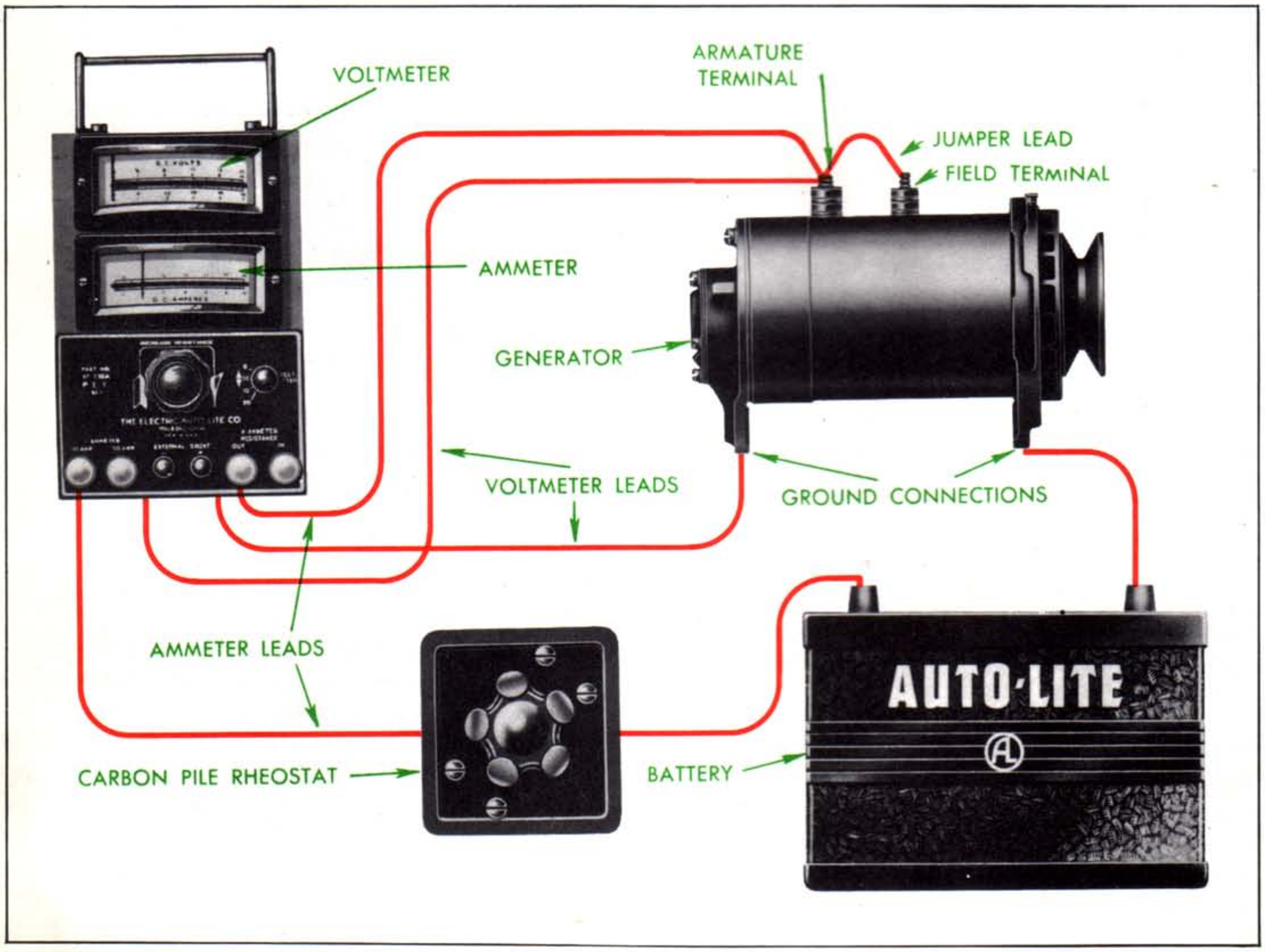


FIGURE 80—MOTORING DRAW TEST DIAGRAM—GENERATORS HAVING FIELD GROUNDED WITHIN THE GENERATOR. This hookup applies to shunt generators which use a heavy duty vibrating regulator. The connections are similar to those in figure 79 except for the field circuit. Connect the battery last to avoid damage to the meters caused by excessive current due to incorrect connections or shorts.

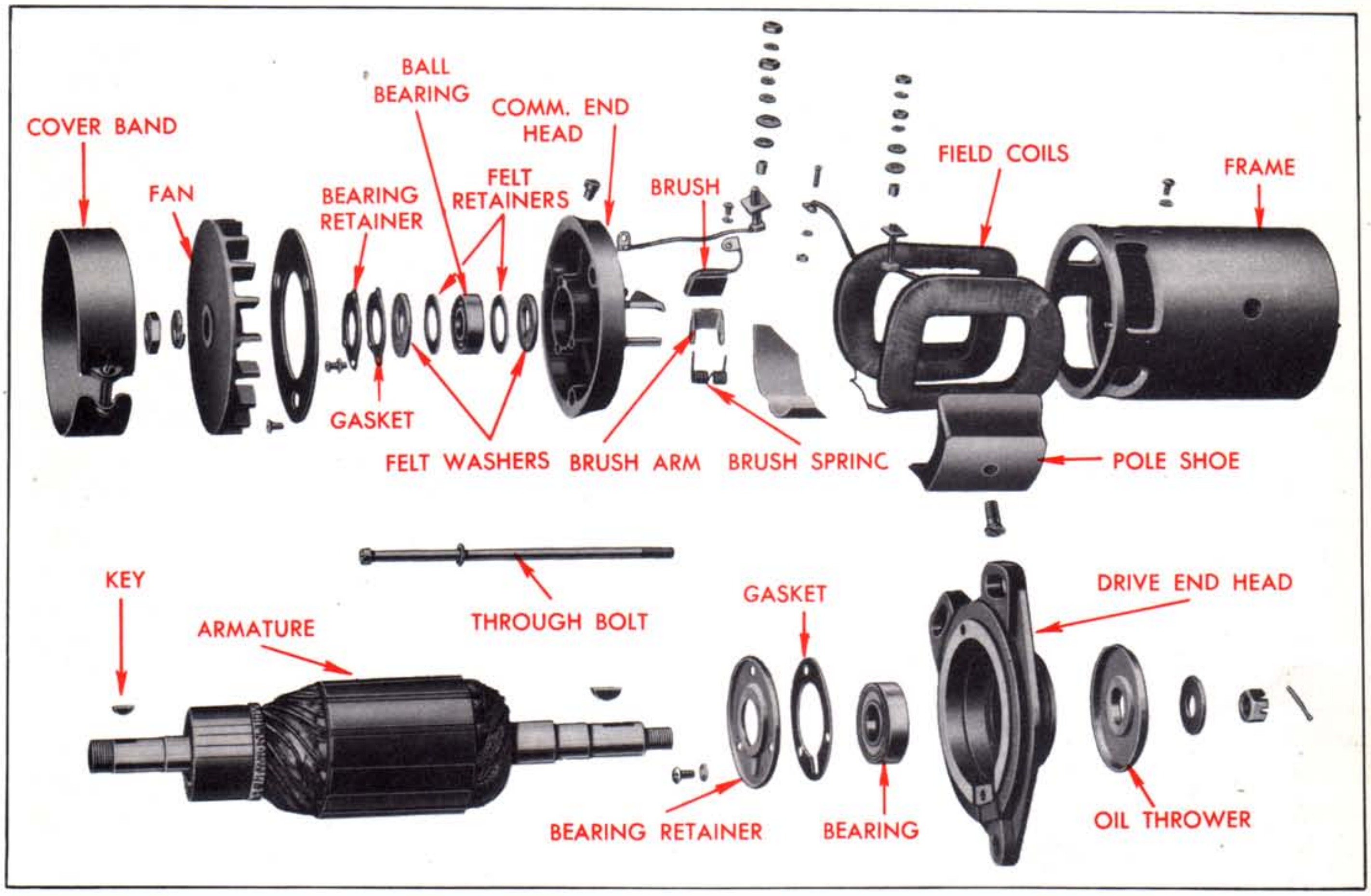


FIGURE 81—EXPLODED VIEW OF GENERATOR WITH THE FAN MOUNTED ON THE COMMUTATOR END. When a generator is gear or coupling driven it is often necessary to mount the ventilating fan on the commutator end. This illustration shows the various parts used in such a unit. The generator illustrated has a ball bearing at the commutator end; however, some units may use a bronze bearing such as illustrated in figure 72.

shaft units usually have a shaft nut to hold the commutator end ball bearing which must be removed before the commutator end head can be taken off.

Usually the armature and drive end head will be removed from the generator as an assembly and, as the bearing is a tight fit on the armature shaft, an arbor press must be used to force the shaft out. Do not pound on the end of the shaft as this damages the shaft threads and may make reassembly impossible.

Pull the drive pulley or gear with the proper tools in order to guard against damaging or misaligning the drive parts. Remove the woodruff key before pressing the shaft out of the drive end head. Some generators also have a woodruff key on the oil thrower while others may have a snap ring on the shaft to hold a fan or bearing spacer in place. These parts must be removed before the armature shaft is pressed out of the head.

ARMATURE INSPECTION

The armature should be visually inspected for mechanical defects such as a worn or bent shaft, worn commutator, scored core laminations and to see that all windings are properly in place in the core slots and are correctly staked and soldered to the commutator. Resolder if necessary being careful not to short between bars.

With test probes (See figure 28) test the armature for grounds by touching the shaft with one probe and each commutator bar in turn with the other probe. Discard the armature if it is grounded as indicated by the lamp lighting.

If the commutator is rough, burned, out of round, or if the mica extends above the surface of the copper it should be turned down in a lathe. Mount the armature by its bearing seats in a lathe as shown in figure 87 and take light cuts until the commutator is completely cleaned up. Remove all burrs with 00 or 000 sandpaper.

Mount the armature with its bearings seats on "V" blocks and place a dial indicator against the commutator. See figure 88. Rotate the armature slowly and read the total indicator movement. Turn the commutator on a lathe as above if it is more than .0005 inch out of round.

Undercut the mica segments to a depth of 1/32" to 3/64". Care should be taken to remove *all* of the mica without making the slot excessively wide. See figures 89 and 90. Remove all burrs with 00 or 000 sandpaper.

Most Auto-Lite armatures can be checked for shorts by placing on a growler and holding a thin steel strip on the core as shown in figure 91. When the armature is rotated slowly the steel strip will become magnetized and vibrate if a short is present. A few of the high output generators, however, have extremely low resistance and use a special internal hookup which causes them to test shorted by the above method. To test these types an AC voltmeter with a full scale reading of 2 to 3 volts is required in addition to the growler. See figure 92. Connect the voltmeter leads to test probes. Place the armature on the growler and turn the switch on (low position if equipped with a switch for high and low current). Adjust the voltmeter test points so that they will touch adjacent bars and touch each pair of segments until the highest reading is obtained. While making this test do not move the armature in the growler. When the highest reading is obtained note the position of the test probes in relation to the growler. Hold the probes in this position and turn the armature in the growler. Read the meter for each pair of segments. Be sure to hold the probes in the same position while the armature is being rotated. The meter reading should be nearly uniform for each pair of segments tested. If a short is present in the armature, the meter reading will be almost zero when testing the shorted coil, while, if an open exists, the meter reading will be extremely high when testing the coil in which the open is located.

If the armature has been treated for resistance to corrosion it should be given additional protection by painting the core and windings and the front face of the commutator with red glyptol. Clean all glyptol from the commutator, bearing seats and shaft threads and allow to dry thoroughly. After drying clean the commutator brush surface with 00 or 000 sandpaper.

FRAME AND FIELD INSPECTION

Clean the frame and field with a cloth dampened in cleaning solvent but do not soak field coils and insulation. Inspect for faulty insulation and stripped threads. Check for grounds in the field coils, leads or terminals by touching each terminal and ground with the test probes. See figure 93. Be sure the leads and their terminals are not touching the frame and remove the field ground screw or fuse if there is a field ground connection.

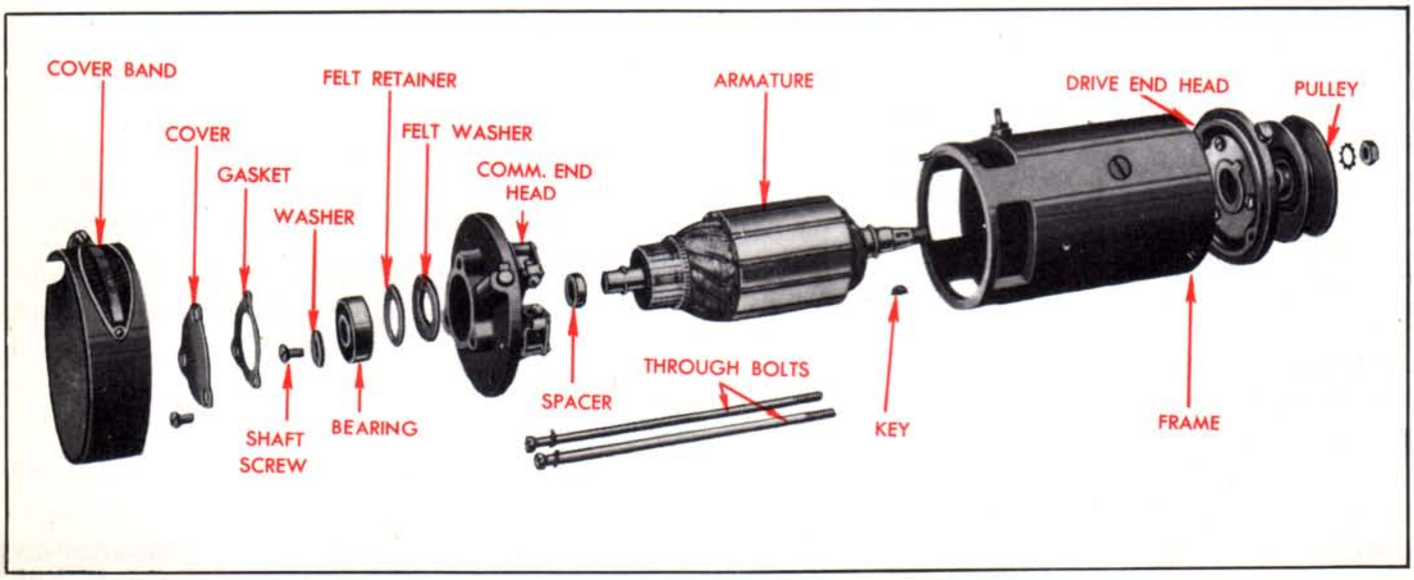


FIGURE 82—MAIN SUBASSEMBLIES OF A SMALL GENERATOR. This is a small diameter generator used on motorcyles and other small engines. Its construction differs slightly from the units illustrated in figures 72 and 81.

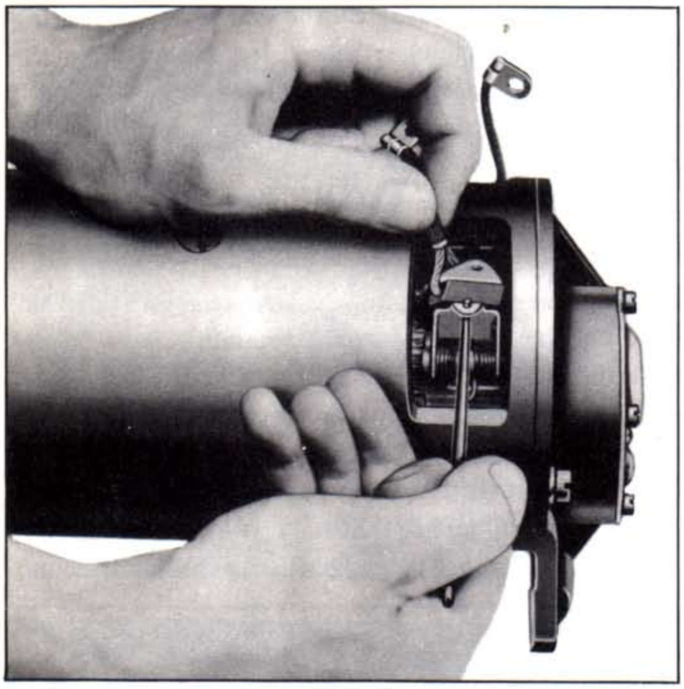


FIGURE 83—REMOVING BRUSHES FROM GENERATOR HAVING REACTION TYPE BRUSH HOLDERS. An ordinary button hook with the end slightly straightened makes an excellent tool for lifting the brush arm.
When removing or installing brushes, care should be taken that the arm or brush does not snap down and cause breaks or chips in the brush.

Connect an ammeter and variable resistance in series between a battery and the two leads of the complete set of field coils, and connect a voltmeter to the coil leads. Adjust the voltage to the specified value and read the ammeter. If the current is not within specifications it indicates faulty coils which should be replaced.

If a ground is present or if the field coil draw is incorrect remove the terminal stud nuts and press the studs out of the frame. If leads are used remove the insulating bushing and take the leads out of the hole in the frame. Inspect the insulating bushing and washers and recheck the field coils for grounds. If the coils are grounded take out the pole shoe screws and slide the coils out of the frame. Replace any faulty parts making sure all connections are properly soldered to make a strong, low resistance connection.

When installing the coils and pole shoes, dip the pole shoe screws in boiled linseed oil before assembly. As the screws are tightened strike the frame one or two sharp blows with a rubber hammer to settle and align the pole shoes.

On corrosion resistant generators and also on some of the heavy duty units, the field coils and inside of the frame should be brushed with air drying insulating varnish. Allow as much varnish to soak into the field coils as possible, but do not soak the brush holder leads or the cut-out relay and regulator leads which must be flexible after the varnish dries. Clean all varnish from the threads and head seats then allow the varnish to dry.

COMMUTATOR END HEAD INSPECTION

Disassemble the head and clean the head, brush plates and holders in cleaning solvent. Do not soak the insu-

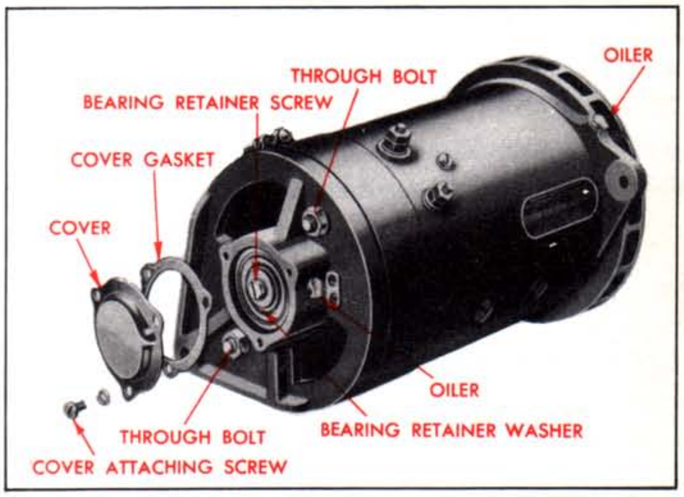


FIGURE 84—COMMUTATOR END CONSTRUCTION OF A GENERATOR WITH A BALL BEARING AT THE COMMUTATOR END. Before the generator can be disassembled the screw in the end of the shaft must be removed.

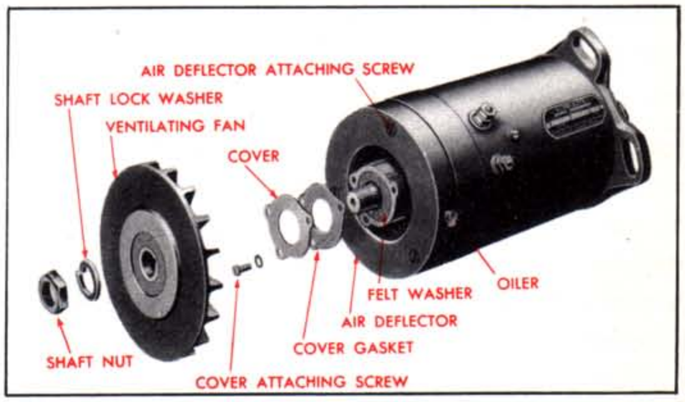


FIGURE 85—COMMUTATOR END CONSTRUCTION OF A GENERATOR WITH A COMMUTATOR END VENTILATING FAN. The fan should be removed with the proper puller to avoid breakage. When the air deflector is removed the through bolts are exposed and can be taken out to complete the disassembly.

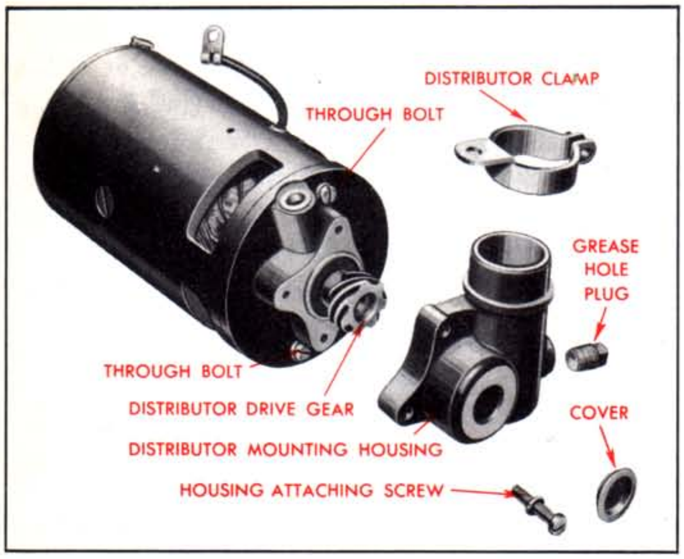


FIGURE 86—CONSTRUCTION OF A GENERATOR HAVING PROVISION FOR MOUNTING A DISTRIBUTOR ON THE COMMUTATOR END. **The gear is larger in diameter than the bearing and must be removed before the head can be taken off.**

lation. Wipe brushes and felts with a clean dry rag. Thoroughly clean the bearing and inspect for wear.

Inspect all parts for damage, wear, and distortion and replace any part not in good condition. Replace the head if the brush holders are loose. Replace brushes if they are oil soaked, worn to less than ½ their original length or if their leads and terminals are frayed, broken or corroded.

Clamp the armature in a padded vise and install the commutator end head on the armature. Place the bearing in position and press it into the head. Feel the side play of the head. If any side movement can be felt it indicates either a worn bearing, bearing recess or shaft. Inspect to locate the worn parts and replace if necessary.

Install the brushes in the holders and inspect to make sure the edges of the brushes are perfectly in line with the commutator segments and that each brush moves freely in its holder. Hook a spring scale in the hole in the end of the brush arm on the type shown in figure 94, or under the brush screw on the type shown in figure 95, and pull on a line parallel to the face of the brush. Take the reading just as the arm leaves the brush or as the brush leaves the commutator depending on the type of construction. On some generators the spring bears directly on the brush and the scale should be hooked under the spring at the end when measuring the tension. To change the tension, disassemble the head and install a new spring or bend the old spring if still in good condition. The correct brush spring tension is important as too much tension will cause rapid wear of the brushes and commutator, while too little tension will cause arcing and reduced output.

If new brushes are being installed they should be sanded to obtain the correct fit on the commutator. With the head and brushes installed on the armature as above, place a strip of 00 sandpaper, cut the exact width of the commutator, under a brush with the sanded side toward the brush. Hold the paper tightly against the commutator and pull so that the brush is forced toward the brush holder. See figure 96. Be careful not to round

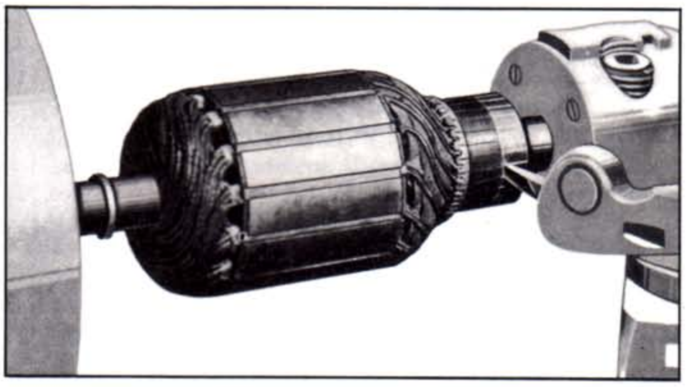


FIGURE 87—TRUING COMMUTATOR ON A LATHE. **When truing up the commutator take light cuts to leave as little burr as possible and to reduce the amount of runout.**
Note that the armature is mounted by the bearing surface and not by the shaft centers.

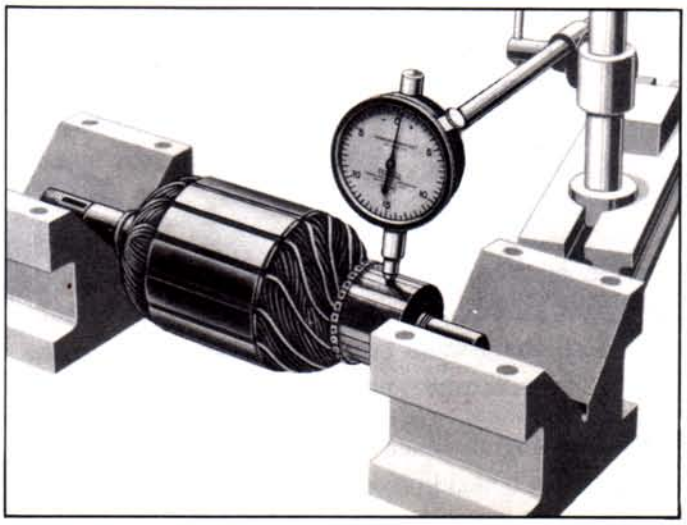


FIGURE 88—MEASURING COMMUTATOR OUT-OF-ROUND **When mounted in this manner and the armature rotated, the indicator reading shows the total runout.**

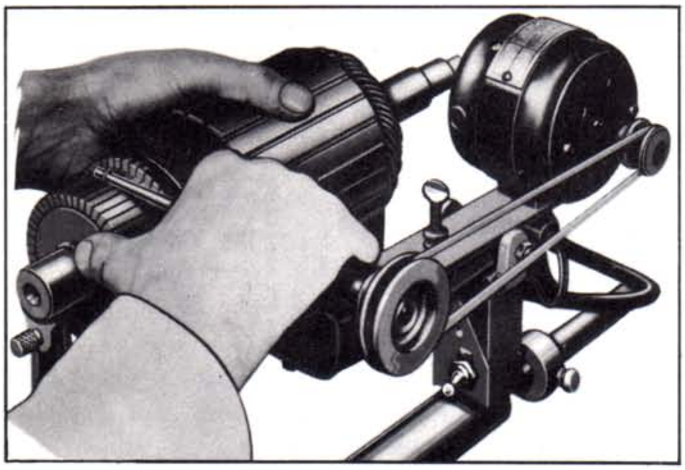


FIGURE 89—UNDERCUTTING COMMUTATOR MICA. Many styles of undercutting machines are available; however, the machine should be fitted with a cutter .002″ thicker than the mica to be undercut and the depth should be adjusted to 1/32″ to 3/64″.

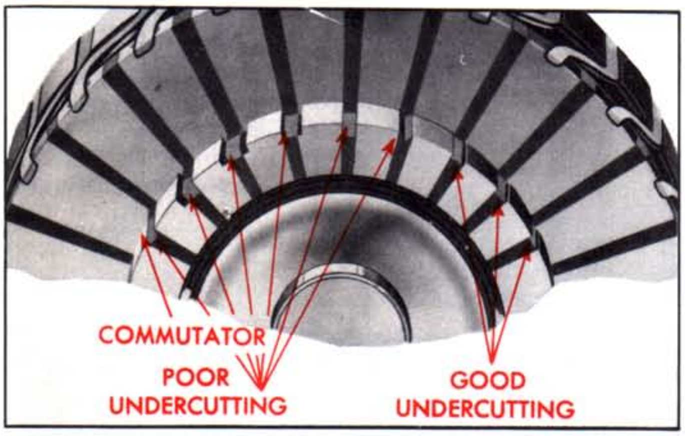


FIGURE 90—SAMPLES OF GOOD AND BAD UNDERCUTTING. Good undercutting is .002″ wider than the mica, exactly centered on the mica, 1/32″ to 3/64″ deep and does not leave burrs on the mica.

or break the edges of the brush and repeat this sanding on each brush. Once or twice is sufficient sanding as additional sanding would merely shorten brush life. After sanding, lift the brush arm with a hook and pull the brush up slightly then clamp in place with the brush arm. Do not remove the brushes entirely as they should not be interchanged after they have been fitted. Always lift the brushes before removing the commutator end head as they may snap off of the commutator and become chipped or cracked.

On corrosion resistant units paint the inside of the head with air drying insulating varnish. Do not paint the brush holders or the pilot and seat as these parts must make an electrical contact after assembly of the generator.

Soak bronze bearings and felts in medium engine oil (S.A.E. No. 10 or No. 20) and drain off excess oil. Pack ball bearings ½ full with a high temperature non-fibre grease.

DRIVE END HEAD INSPECTION

Disassemble the head and thoroughly clean all parts except the felts and ball bearings in cleaning solvent. Wipe felts with a clean dry rag. If bearing is of the open type it can be cleaned in solvent but sealed ball bearings should be wiped clean. Do not dip this type bearing in solvent as it cannot be relubricated.

Inspect all parts for wear, cracks, distortion, and other damage and replace any parts not in good condition. Be sure bearing recess is not worn and that bearing is a snug fit. Pack ball bearing ½ full with a high temperature non-fibre grease. Soak bronze bearings and felts in medium engine oil and drain off excess oil. Felt washers should be squeezed to remove excess oil before the head is assembled.

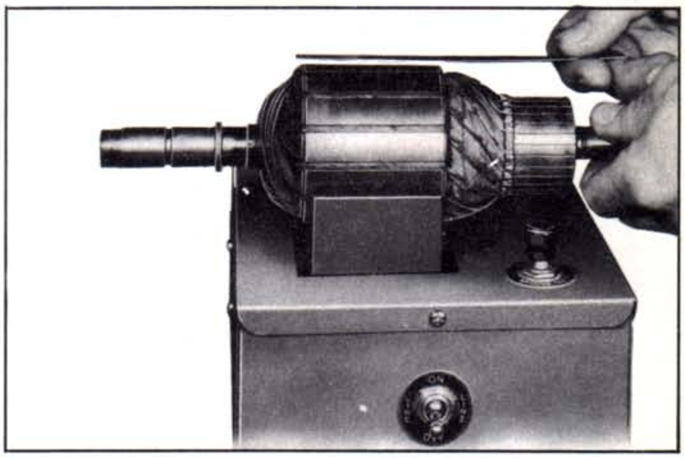


FIGURE 91—GROWLER AND STEEL STRIP TEST FOR ARMATURE SHORTS. The steel strip is held stationary near the armature and the armature is rotated. If a short is present the steel strip will vibrate.

MISCELLANEOUS PARTS

Clean all parts thoroughly and inspect for damage that would cause improper functioning. Felts and insulating parts should not be dipped in cleaning solvent but should be cleaned with a dry or slightly dampened rag. Drive pulleys and fans should be in perfect condition without cracks or broken blades and with no rough spots on the belt groove.

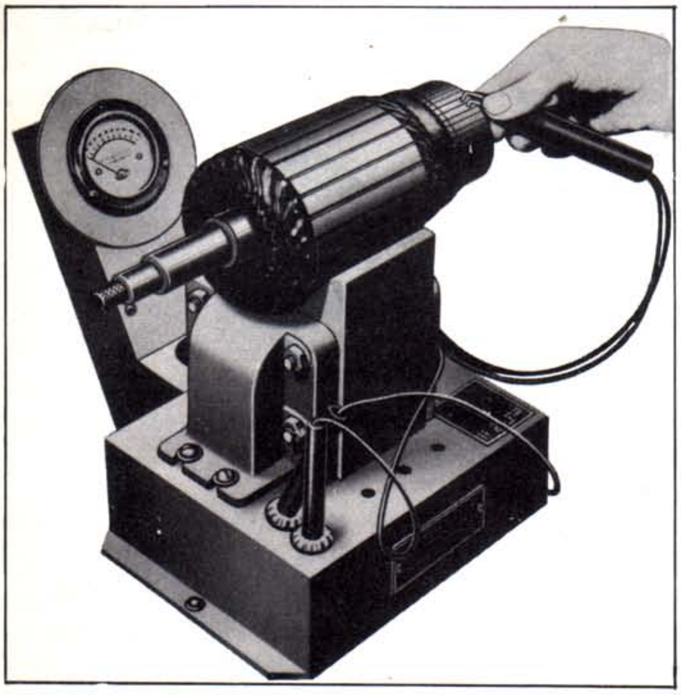


FIGURE 92—VOLTMETER TEST FOR ARMATURE SHORTS. Some generators have internal connections that cause them to check shorted by the steel strip method and it is necessary to make a comparison of the voltage induced in each coil by the growler. Keep the contacts stationary after the highest reading is obtained and rotate the armature to check each pair of segments.

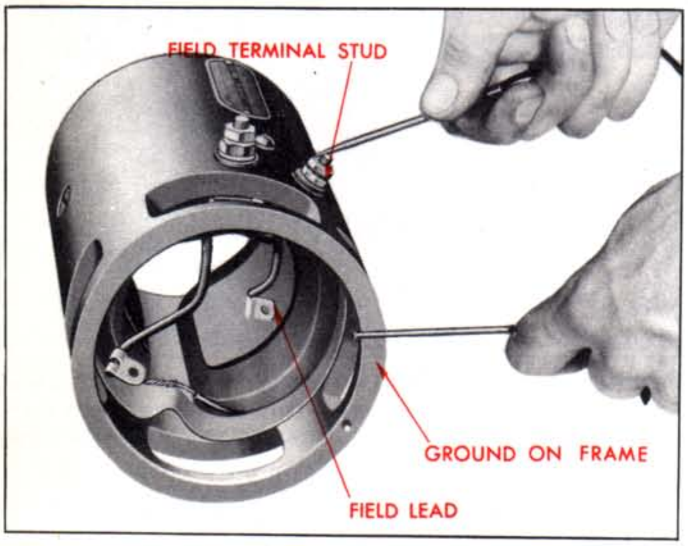


FIGURE 93—TESTING FIELD COILS FOR GROUNDS. Use test probes similar to those illustrated in figure 28 to check from the field terminal to ground. On some types it is necessary to first remove the field ground connection.

ASSEMBLY

When assembling the armature and drive end head make sure that the snap ring or shoulder on the armature shaft is pressed firmly against the inner race of the bearing. When a felt washer retainer is used it should be installed on the shaft over the snap ring before pressing the shaft into the bearing. This retainer turns with the shaft and inner race,and prevents tearing of the felt washer by the snap ring.

When installing through bolts care must be taken that the lower bolt is installed under the loop in the field connection insulation to prevent grounding of the field coils by the bolt. See figure 97.

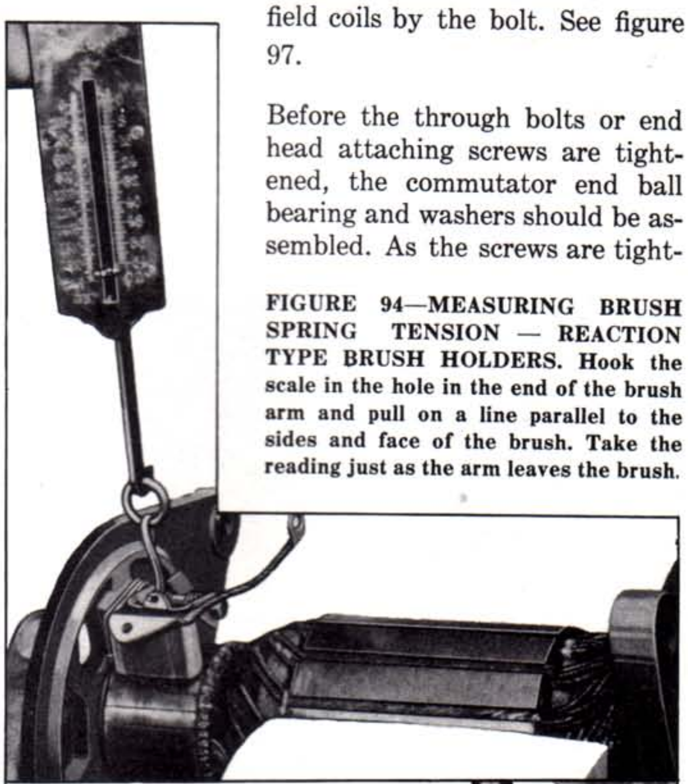


FIGURE 94—MEASURING BRUSH SPRING TENSION — REACTION TYPE BRUSH HOLDERS. Hook the scale in the hole in the end of the brush arm and pull on a line parallel to the sides and face of the brush. Take the reading just as the arm leaves the brush.

Before the through bolts or end head attaching screws are tightened, the commutator end ball bearing and washers should be assembled. As the screws are tightened, the frame should be given a few sharp blows with a rubber hammer to settle and align the bearings.

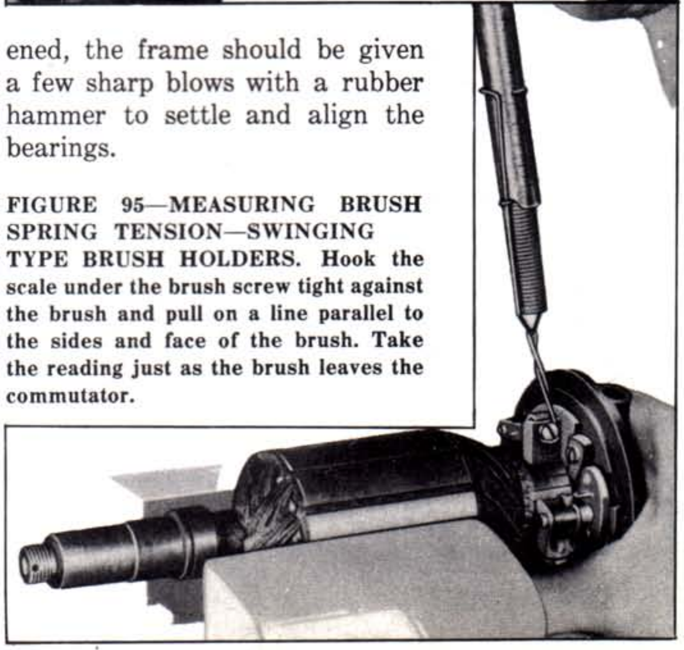


FIGURE 95—MEASURING BRUSH SPRING TENSION—SWINGING TYPE BRUSH HOLDERS. Hook the scale under the brush screw tight against the brush and pull on a line parallel to the sides and face of the brush. Take the reading just as the brush leaves the commutator.

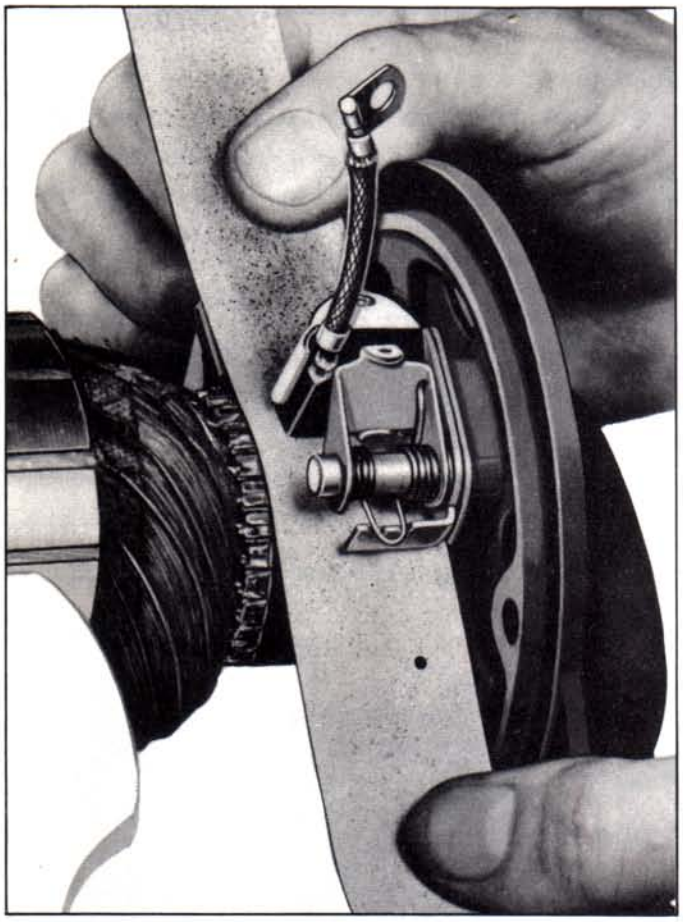


FIGURE 96—FITTING NEW BRUSHES WITH 00 OR 000 SANDPAPER. Cut the sandpaper the exact width of the commutator and place it under a brush with the sanded side out. Hold the commutator end head firmly and pull the paper so that the brush is forced toward the holder.

When installing commutator end heads equipped with a bronze bearing, oil reservoir and wick care must be taken that the wick is not torn when the shaft is inserted. The best method of preventing damage is to remove the felt wick and re-install it after the head and armature are assembled on the generator.

As a check on the generator assembly, measure the end play with a dial indicator. Mount the indicator on the generator with its plunger in line with, and resting against the end of the armature shaft as shown in figure 98. Move the armature to its extreme positions and read the total end play. This should be .003″ to .010″ which is the end play of the drive end ball bearing. Incorrect end play is usually caused by a loose or improperly assembled drive end head or by the insertion of too many washers and felt retainers inside of the commutator end bearing.

After the generator is assembled add 10 to 12 drops of medium engine oil to the oilers and fill the commutator end oil pocket with medium oil.

GENERATOR TEST

Check Field Coil Draw

Connect an ammeter and variable resistance in series with one field coil lead or terminal and a battery terminal. Connect the other field coil lead to the second battery terminal and connect a voltmeter to the two field coil ends. The field coil connections vary with the type of generator and may be any one of the following:

1. Third brush terminal to generator frame. (Figure 99).
2. Third brush terminal to regulator field lead. (Figure 100.)
3. Third brush terminal to field terminal stud. (Figure 100.)
4. Field terminal stud to armature terminal stud. Figure 101.)
5. Field terminal stud to generator frame. (Figure 102.)

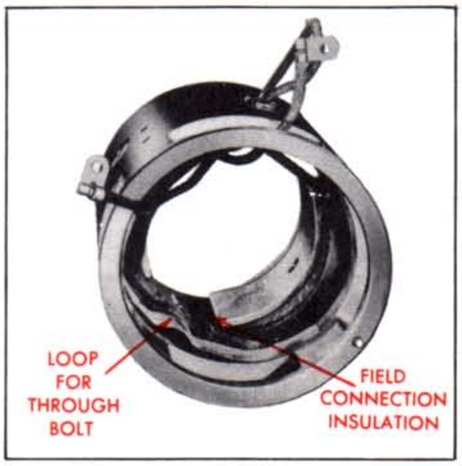


FIGURE 97—FRAME AND FIELD ASSEMBLY SHOWING THE FIELD CONNECTION INSULATION. When inserting the lower through bolt, be sure it is installed under the loop in the insulation as it may strike the field connection and ground the coils.

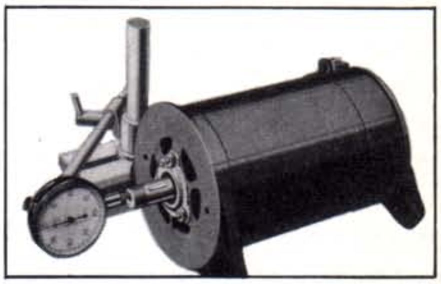


FIGURE 98—MEASURING GENERATOR END PLAY. There is no adjustment of the armature end play. If it is not between .003 and .010 inch it indicates either a worn drive end ball bearing or incorrect generator assembly.

The first three of these hookups always are third brush type generators while the last two are shunt type units. The first type has no external field connection while the second and third types are easily identified by a visual inspection as the third brush is present and the field

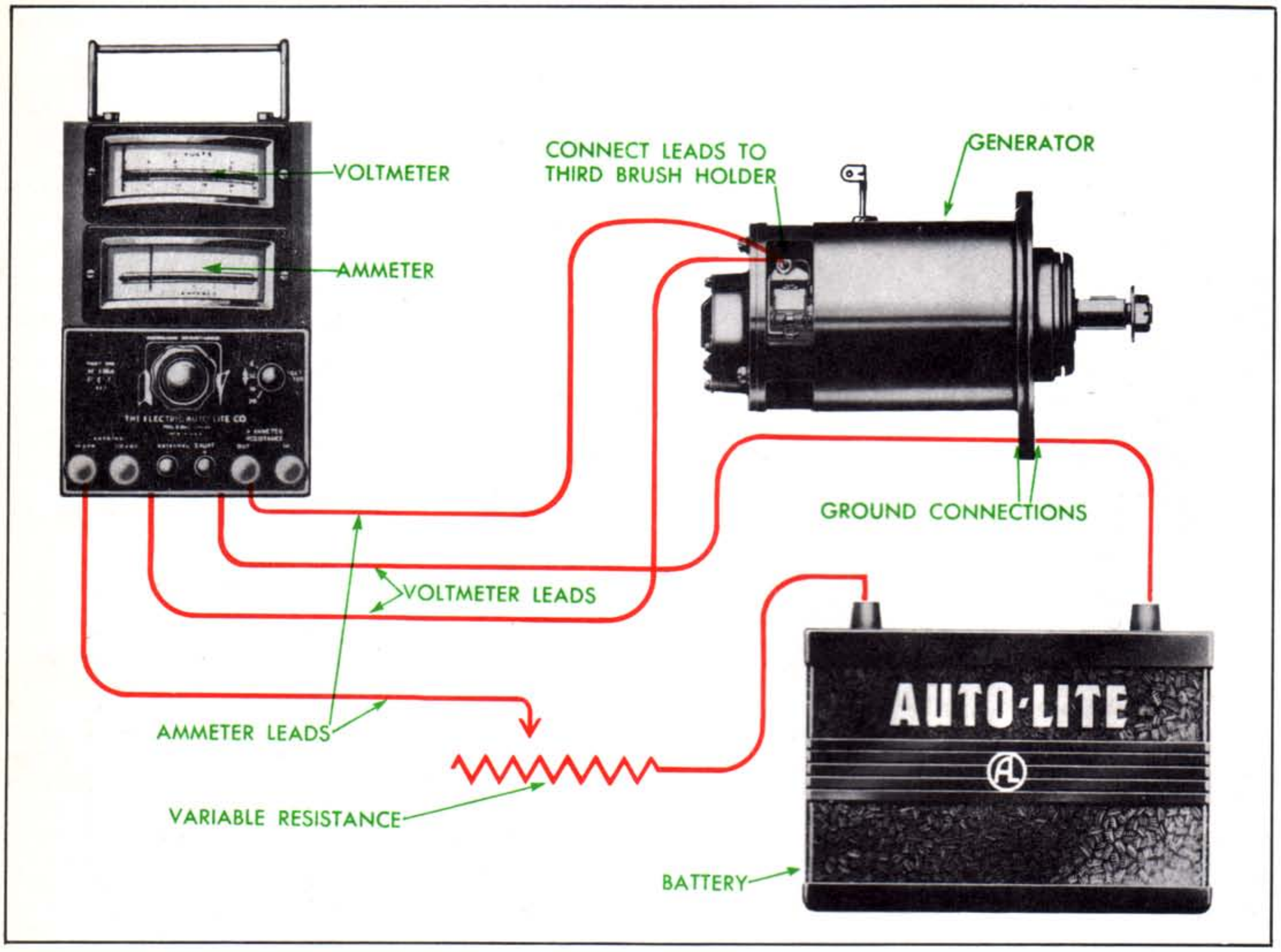


FIGURE 99—HOOKUP FOR MEASURING FIELD COIL DRAW—GENERATORS WITHOUT AN EXTERNAL FIELD LEAD OR TERMINAL. Use these connections when measuring the field coil draw of generators without an external field circuit. **Be sure to insulate the third brush from the commutator when making the test as additional current would flow through the armature and give a false reading.**

lead or terminal is on the outside of the frame. The fourth type has one field coil lead connected to the field terminal stud and the other field lead connected either to the armature terminal stud or the insulated main brush holder. The last type has one field lead connected to the field terminal stud while the second field lead is grounded either to the frame or to one of the grounded brush holders. The last type is used only in generators for use with a heavy duty current and voltage regulator and is not as common as the other four.

When measuring the field coil draw of plain third brush generators (type No. 1 above) it is necessary to lift the third brush from the commutator when making the test or to insulate the brush from the commutator with a piece of paper. If this is not done additional current will flow through the armature and give a false reading.

If the field current draw is not within limits it indicates either incorrect connections or a shorted, open or grounded coil which must be replaced.

Check Motoring Draw

(Refer to figures 78, 79, and 80.)

On the second, third, and fourth types of field connections described above, complete the field circuit by grounding the external field connection to the generator frame. On the fifth type complete the circuit by connecting the field terminal to the armature terminal with a jumper lead.

Ground the generator frame to the battery according to the polarity specified for the unit being tested. Connect an ammeter and variable resistance in series between the armature lead or terminal and the other battery terminal. Adjust the voltage to the specified value and read the ammeter. The current should be within specifications and the generator should operate as a motor with the armature turning slowly.

On generators having an adjustable main brush plate the neutral position should be located and the brushes turned the specified distance from the neutral position. To locate the neutral position connect the generator for the motoring test and loosen the brush plate clamp screw. Rotate the brush plate and feel the armature until there is no tendency to turn in either direction. This is the neutral position. The brush plate should be rotated in the direction of armature rotation the specified amount and the clamp screw tightened.

On third brush generators the third brush should be set at its approximate final position before checking the motoring draw.

If the motoring draw is not within limits it indicates faulty armature, fields, connections or interference with armature movement. Check for excessive drag on the armature and for high resistance. Pay special atten-

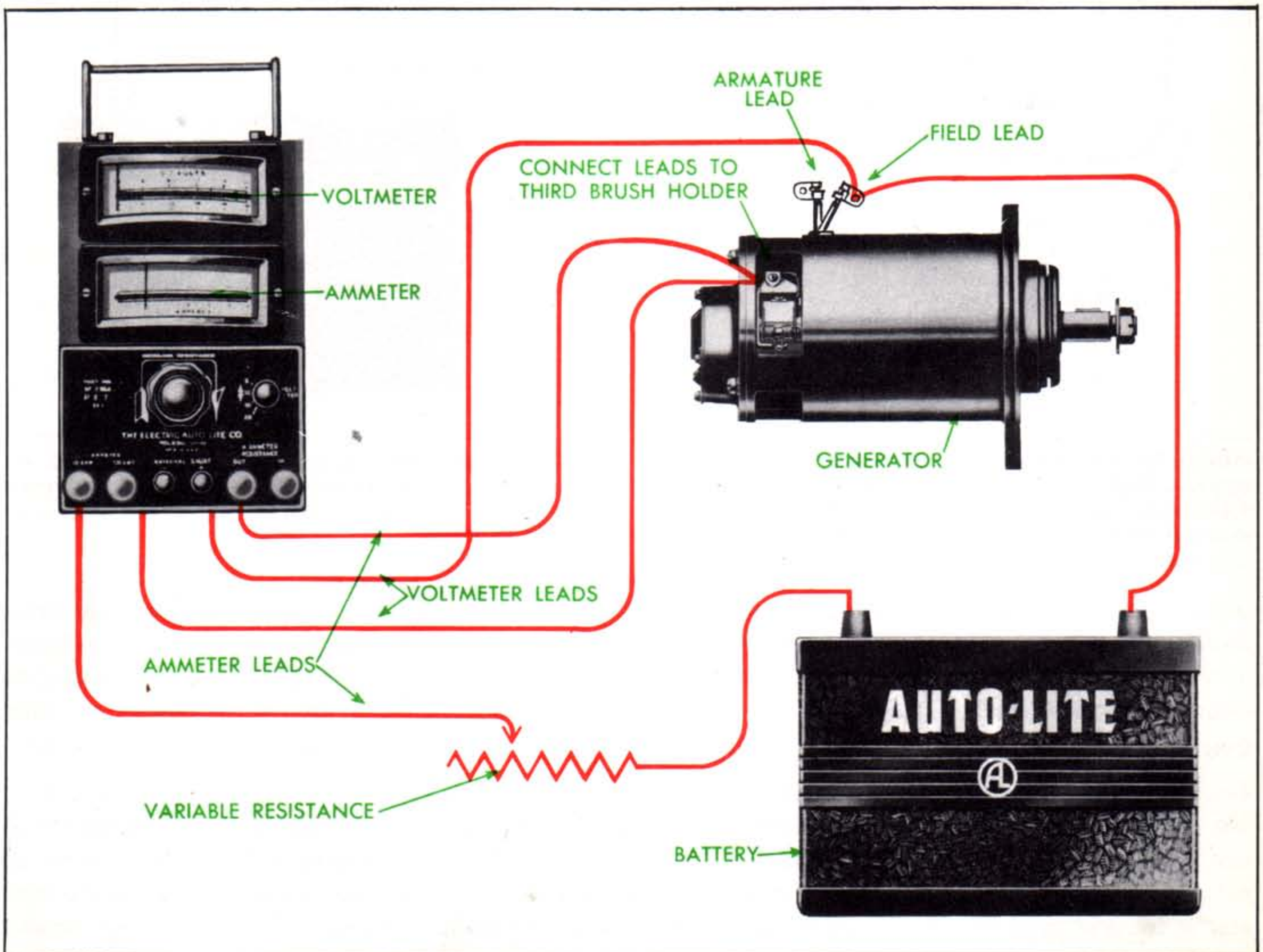


FIGURE 100—HOOKUP FOR MEASURING THE FIELD COIL DRAW—THIRD BRUSH GENERATORS WITH TWO STEP OR VIBRATING REGULATION. The field coils, ammeter, rheostat and battery are connected in series and the voltmeter is connected across the field coils. Connect the battery last and check for possible shorts that would damage the meter.

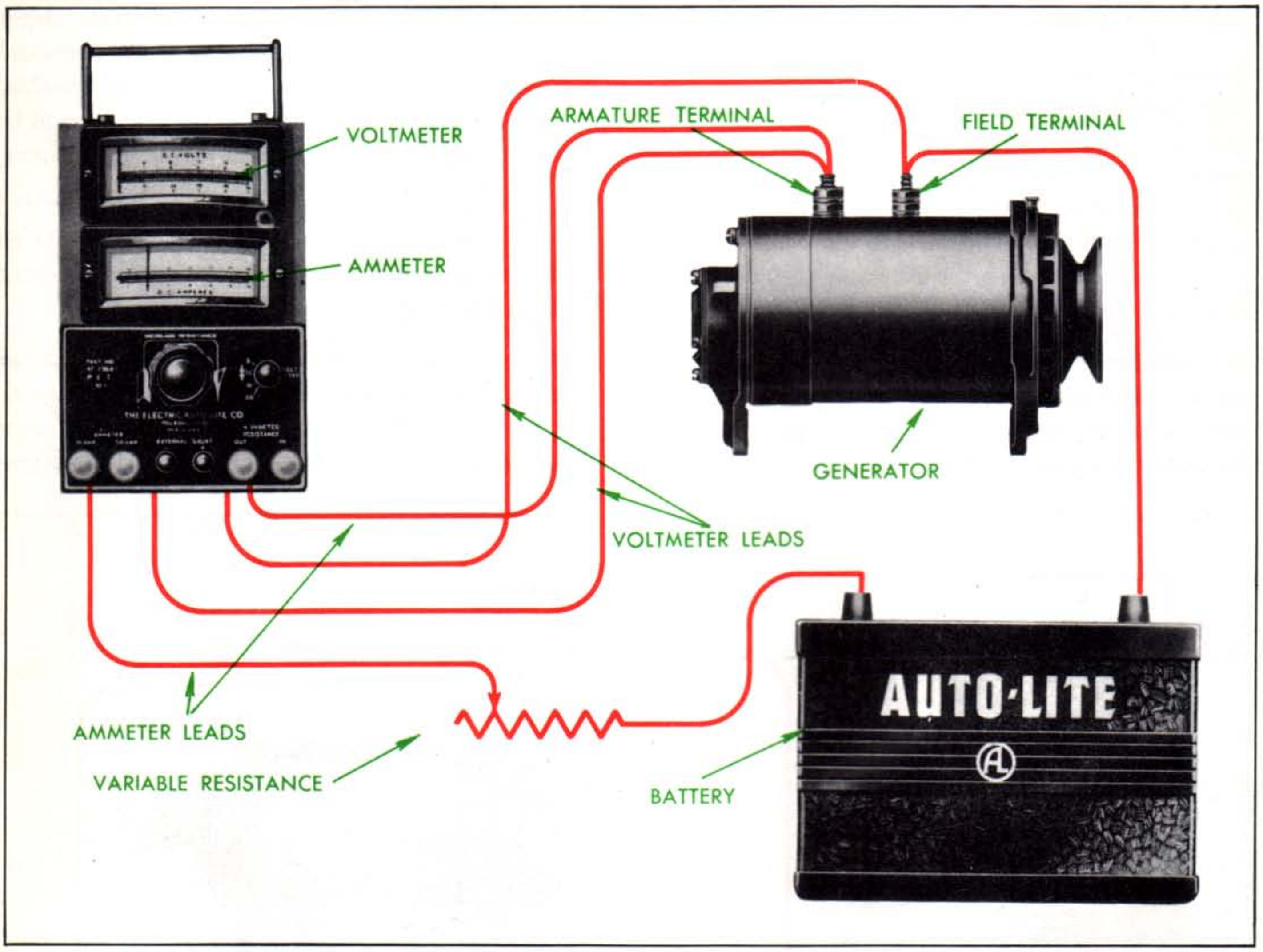


FIGURE 101—HOOKUP FOR MEASURING THE FIELD COIL DRAW—SHUNT GENERATORS WITH FIELD GROUNDED THROUGH THE REGULATOR. An inspection of the unit will show that one field lead is connected to the field terminal and the other to either the armature terminal or the insulated brush. The ammeter, rheostat, and battery are connected in series with, and the voltmeter is connected across the coils. Connect the battery circuit last to avoid damage to the meters due to shorts or incorrect connections.

tion to the fit of the brushes on the commutator and, if necessary, operate as a motor for a short period to run in the brushes. Cool the generator after this run-in before making another motoring draw test.

Output Tests

Connect the generator as described above for motoring test except remove the variable resistance from the circuit and add a load rheostat across the battery terminals. See figures 103, 104, and 105. Connect the generator to the driving motor and operate in the specified direction of rotation. Increase the speed slowly and hold the voltage at the specified value by adjusting the load. On shunt type generators, note the speed when the specified output is obtained; and on third brush generators, note the peak output as the speed increases. Adjust the third brush to give the specified output by placing a screw driver against the base of the third brush holder stud and tapping lightly with the hand.

If the speed is higher than the specified value or if the rated output cannot be obtained, inspect for inadequate brush seating, high resistance and for faulty armature or fields. Also make sure the brush position has been correctly set as described in the motoring test. Brushes are seated properly when upon inspection they show contact over the full width of the brushes and at least 75% of the total surface. See figure 106.

If the brushes are nearly seated they can be run in to obtain a perfect seat by operating the generator under load.

If brushes show contact with the commutator over a small fraction of the possible surface it may be necessary to seat them with 00 or 000 sandpaper. Cut the sandpaper the exact width of the commutator and place the strip under a brush with the sanded side toward the brush. See Figure 107. Hold the sandpaper tightly against the commutator and pull so that the brush is forced toward the holder. Sand each brush once or twice to obtain a perfect fit. Too much sanding will merely shorten brush life, without improving the seat. After sanding, operate the generator at about ¾ to full load for a short period until the brushes are perfectly seated. After this run-in, cool the generator to room temperature before making another output test.

It is important that generator tests are made when the generator is at room temperature as heat increases the resistance of the windings and changes the operating characteristics. For this reason all specifications are given on the basis of a cool generator. In the rare occasion when a hot generator must be tested, a higher speed must be allowed to obtain the rated output of shunt generators and third brush generators must have the peak output set 3 or 4 amperes lower than that specified.

INSTALLATION

Install the cover band on the generator and paint the

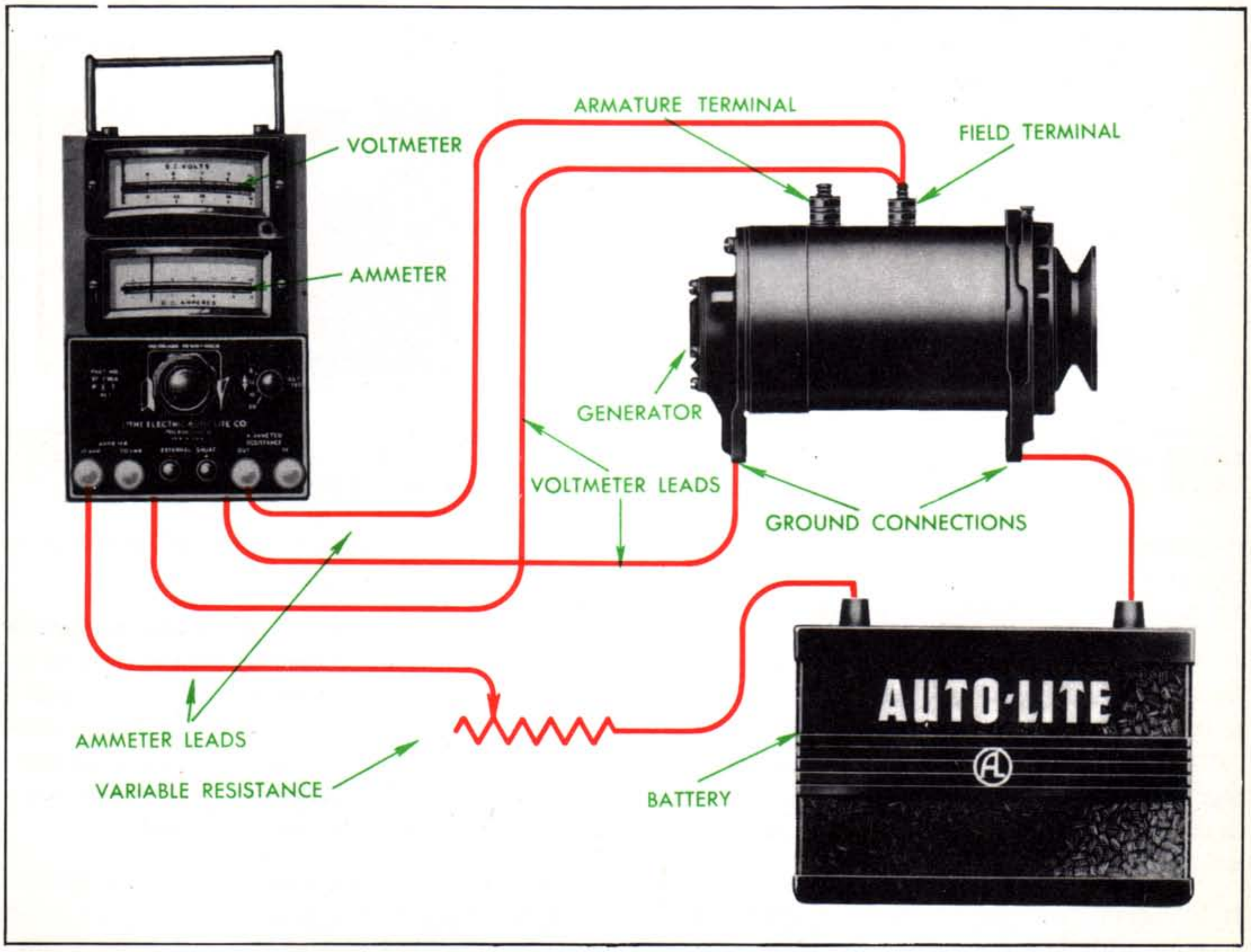


FIGURE 102—HOOKUP FOR MEASURING THE FIELD COIL DRAW—SHUNT GENERATORS WITH THE FIELD GROUNDED WITHIN THE GENERATOR. **This diagram is similar to figure 101 except that the generator uses a heavy duty regulator and the field is grounded within the generator either to the frame or to the grounded brush holder.**

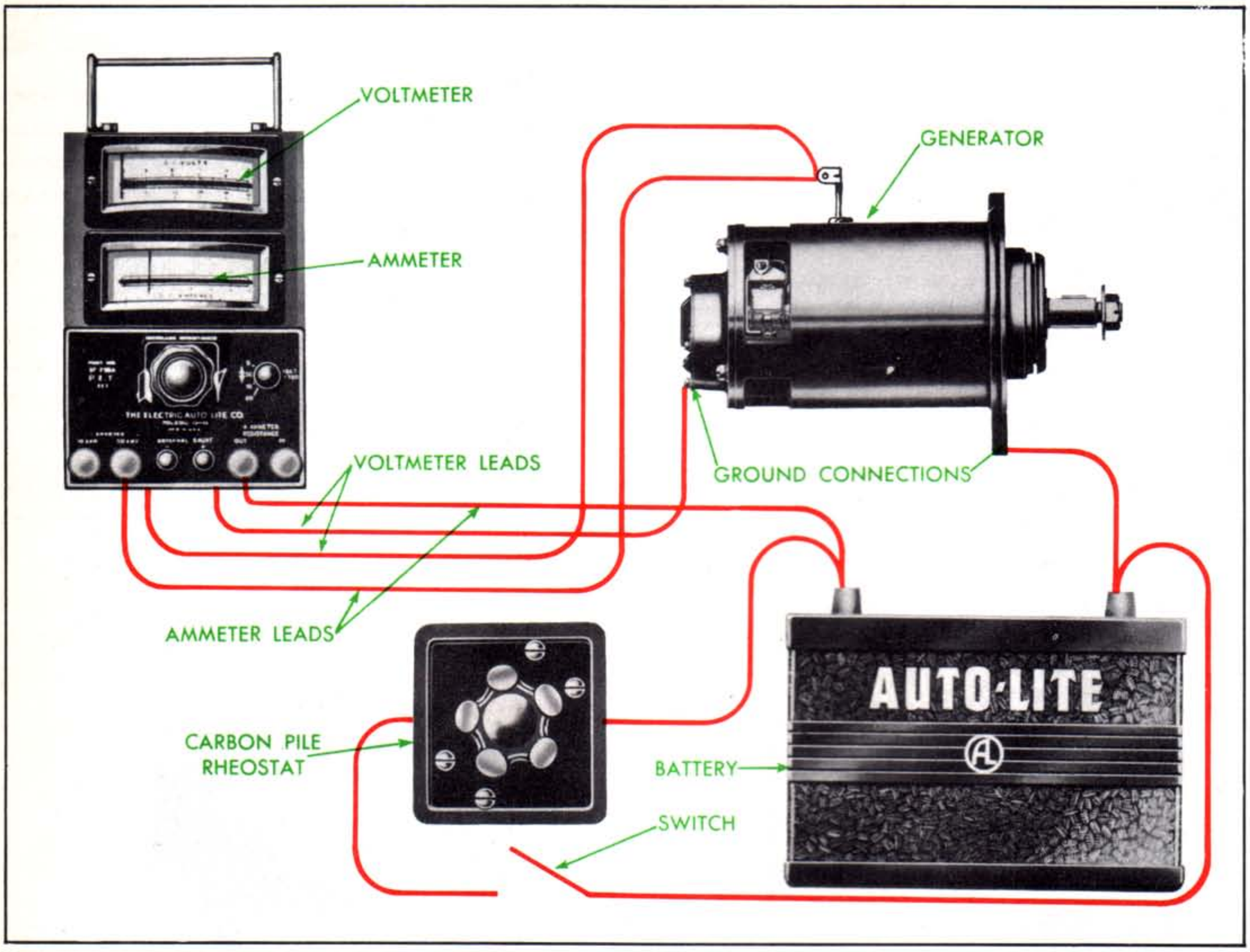


FIGURE 103—DIAGRAM FOR TESTING THE GENERATOR OUTPUT—NO FIELD TERMINAL. Be sure the load rheostat is disconnected from the battery when the test is finished as it would soon discharge the battery.

outside with air drying enamel. Do not paint the terminals, plated parts or mounting faces. Wipe all paint from the name plate and the belt groove and allow to dry.

If the cutout relay or regulator mounts on the generator frame, connect the lead from the insulated main brush to the "A" terminal and connect the field lead to the "F" terminal then mount the regulator on the generator. Be sure to use lockwashers on the mounting screws as the regulator must be firmly mounted and must be grounded to the generator.

It is desirable that the regulator be checked while operating with the same generator it will control when in use. If the test equipment is available the generator should be placed on the test stand and the regulator connected and tested as described in the section on regulator test and adjustment.

Install the generator on the engine and connect the leads. Adjust the belt tension so that there will be approximately 1 inch deflection when a 5 pound pull is applied to the belt in the center of its longest span. This belt tension varies somewhat from the above figure with the various installations and the engine manufacturers specifications should be followed.

After the generator is installed and before it is operated it should be polarized to prevent vibrating the cutout relay armature and burning the contacts. Generators can be polarized by making all connections between the generator, regulator, and battery and then making a momentary connection from the starting switch or regulator battery terminal to the armature terminal on all generators except those using a heavy duty type regulator. On these units disconnect the field lead from the regulator and momentarily touch it to the battery terminal.

THE GENERATOR CONTROL

All automotive type generators require some method of controlling the output and limiting it to a value that is safe for the generator and load. The simplest of these controls is the third brush method which was described in the generator section. The third brush control may be used alone with no other output control or there may be a two charge regulator or vibrating voltage regulator used in addition to the third brush. Shunt type generators require the use of a vibrating current regulator to limit the generator output to its maximum safe output. This current regulator is always used in conjunction with a vibrating type voltage regulator.

On some third brush generators used on early busses and on some present day tractor or marine applications a resistor is combined with the light switch. This resistor is connected in the generator field circuit when the lights are turned off and reduces the generator output to a low value. When the lights are turned on, the resistor is shorted out and the generator charges at its maximum rate as controlled by the third brush. Usually there is an intermediate switch position where the resistor is shorted out even though the lights are not turned

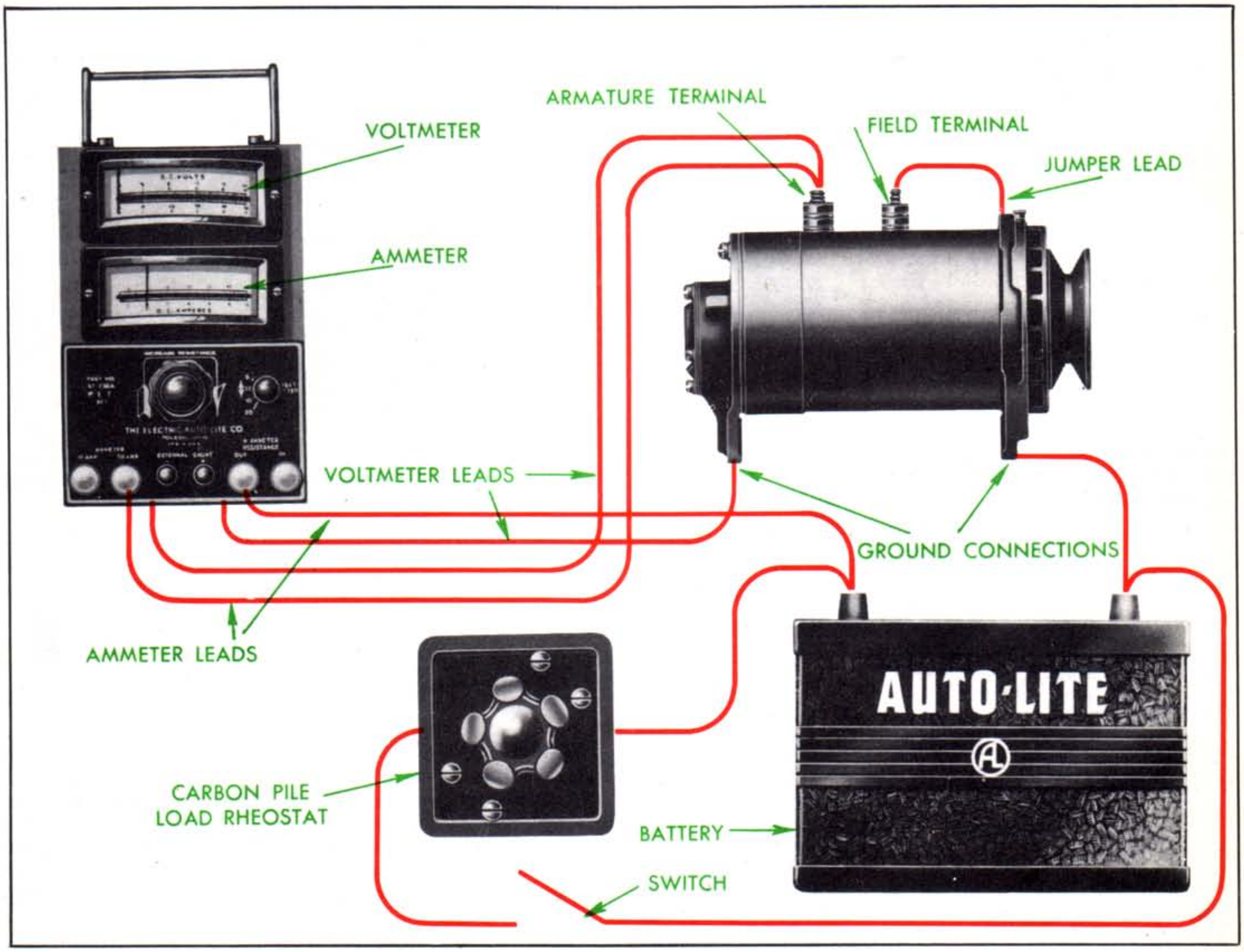


FIGURE 104—DIAGRAM FOR TESTING THE GENERATOR OUTPUT—GENERATORS HAVING FIELD GROUNDED IN REGULATOR. This hookup is used for both third brush and shunt generators which use a two step or standard vibrating voltage regulator.

Be sure load rheostat is connected only during the test to avoid discharging the battery.

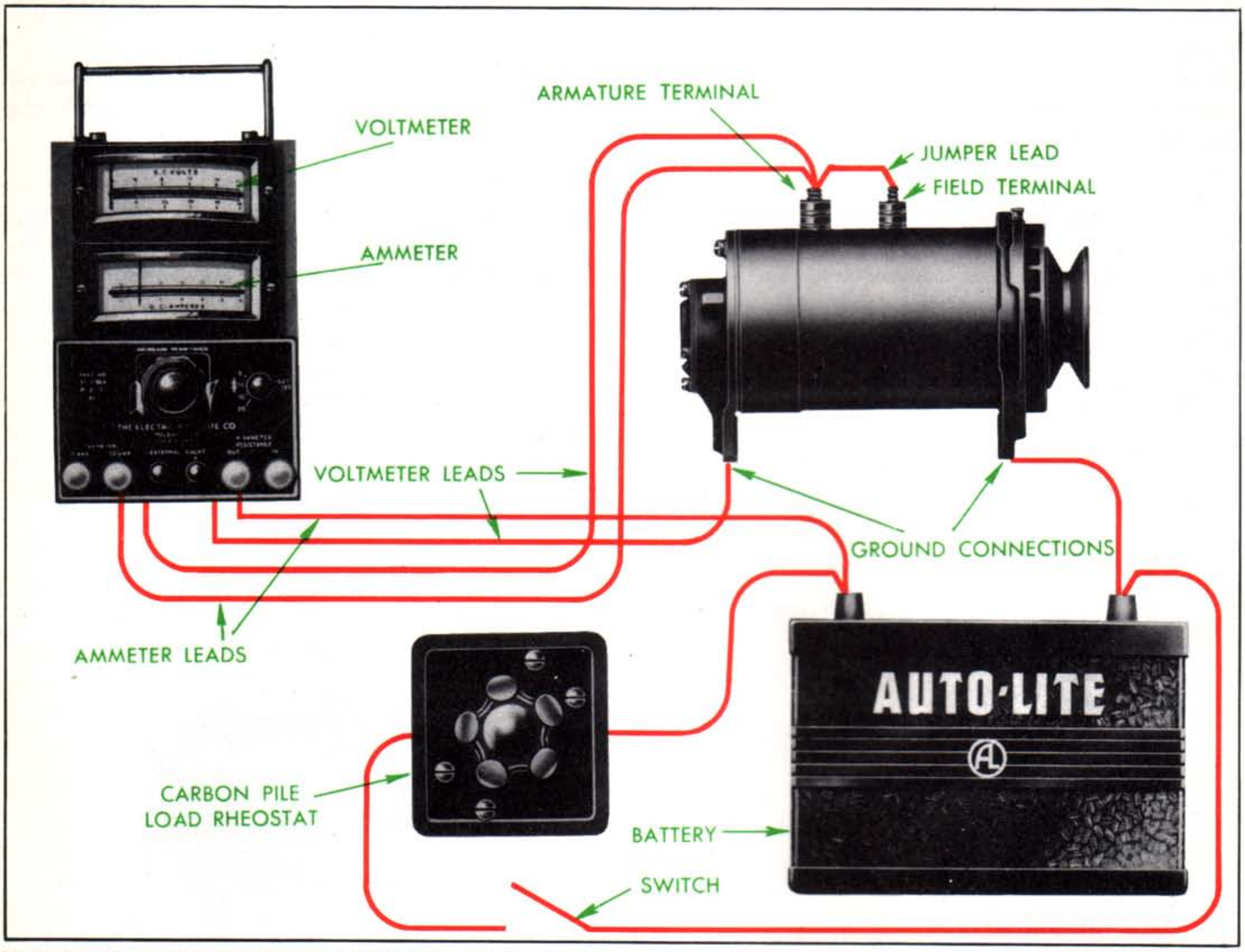


FIGURE 105—DIAGRAM FOR TESTING THE GENERATOR OUTPUT—SHUNT GENERATORS USING A HEAVY DUTY CURRENT—VOLTAGE REGULATOR. The connections for this test are the same as those shown in figure 104 except for the jumper lead which completes the field circuit.

on. This enables the operator to select the maximum generator output to take care of special circumstances that may arise.

A cutout relay is used to connect the generator to the battery when the generator begins to charge and disconnect the generator from the battery when the generator slows or stops and the battery begins to discharge through the generator windings. This cutout relay is used with all generators designed for use in a battery system and may be used alone on a plain third brush generator or combined on the same base with a two charge voltage regulator, vibrating voltage regulator or vibrating current and voltage regulator.

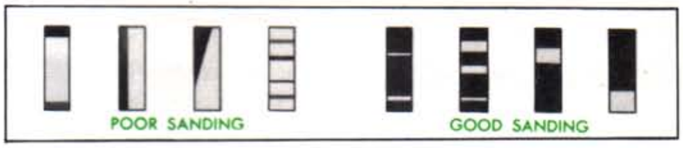


FIGURE 106—SAMPLES OF BRUSH SEATING. After a brush has been sanded or run-in by operation there is a difference in appearance between the part that makes actual contact with the commutator and the part that does not quite touch. Removing the brush and comparing its contact surface with this illustration will indicate whether the seat is satisfactory. In general, the brush should make contact over the full width and at least 75% of its length.

THE CUTOUT RELAY

The cutout relay, figure 108, has two contacts, one of which is mounted on a stationary bracket and the other on a magnetically attracted armature. The armature is hinged at one end and a spring is arranged to keep the contacts separated when the unit is at rest. Usually the movable contact is mounted on the armature through a spring arm as shown in figure 114, in order to give more positive opening and to provide for a slight wiping action each time the contacts open or close. This wiping action helps to give a good contact and reduce resistance in the connection. On some heavy duty cut-out relays two or more sets of contacts are used. See figure 115. These multiple sets are connected in parallel and are mounted in the same manner so that they operate simultaneously. This increases the contact area and reduces the voltage loss on high current relays.

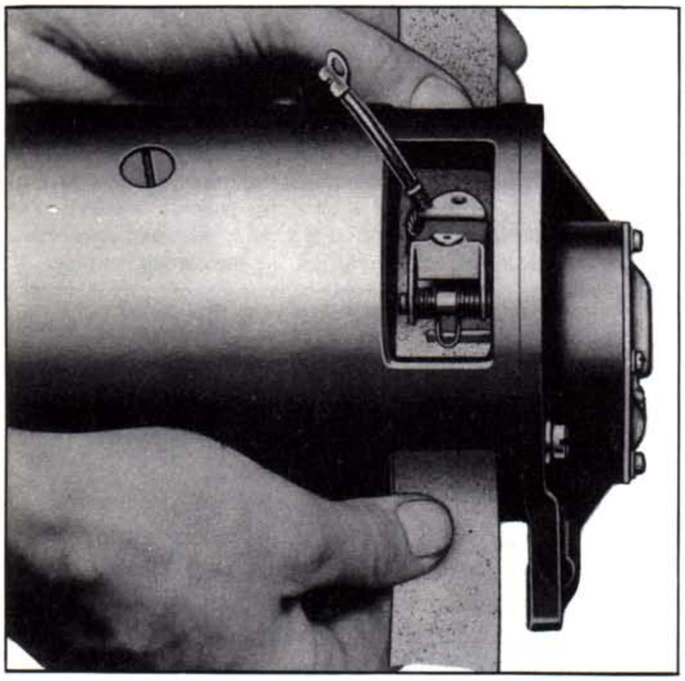


FIGURE 107—FITTING NEW BRUSHES. 00 or 000 sandpaper should be used and cut the exact width of the commutator. Place the paper under a brush with the sanded side out and hold it tightly against the commutator while pulling so that the brush is forced toward the holder.

An electromagnet is used of offset the spring tension and pull on the armature to close the contacts. This electromagnet has two windings; one of which (the shunt coil) consists of many turns of fine wire and is connected from the generator circuit to ground so that its current depends upon the generator voltage. The other winding (the series coil) has comparatively few turns of heavy wire and is connected so that all of the generator current output flows through it. See figure 109. These two coils are wound in the same direction so that when the generator is charging the battery, the magnetism of the two coils combines to increase the pull on the armature. When the battery discharges through a slowed or stopped generator, the current in the series coil is reversed and the magnetism of the series coil opposes the magnetism of the shunt coil. This reduces the magnetic pull on the armature and the spring separates the contacts.

The sequence of the operation of the cut-out relay is as follows:

When the generator is not running the spring holds the contacts open. When the generator is started, the voltage builds up at the armature terminal and in the shunt coil (See figure 116); and, as soon as the voltage reaches the value for which the cutout relay is calibrated, there is sufficient magnetism created by the shunt coil to pull down the armature. This closes the contacts which automatically completes the circuit between the generator and battery. With the contacts thus closed current flows from the generator through the series coil and cutout relay contacts to the battery. Since the current

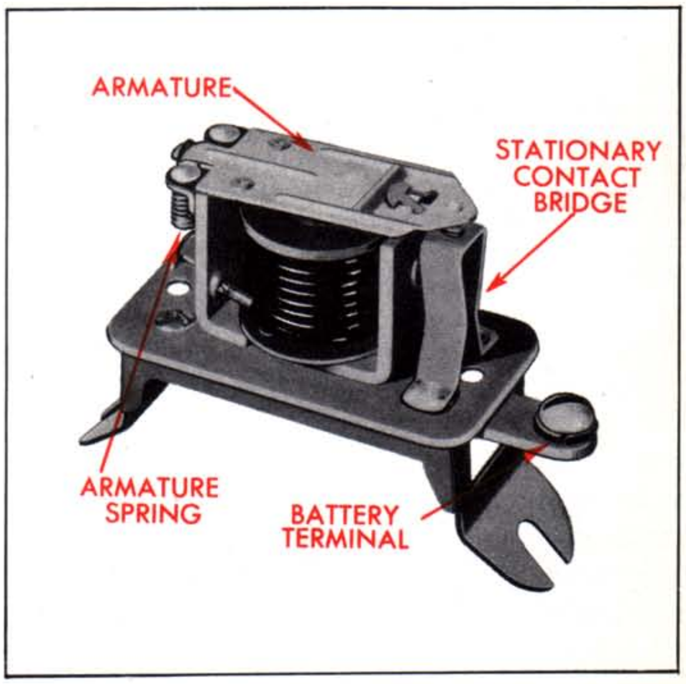


FIGURE 108—CUT-OUT RELAY WITH COVER REMOVED. This is a reverse current relay used with plain third brush generators. A voltage winding causes the contacts to close when the generator is in operation and the series winding opposes the shunt winding when the battery discharges through a stopped generator. The spring holds the contacts apart when the unit is at rest.

is flowing from the generator to the battery, the magnetism of the series coil increases the total magnetism and holds the contacts firmly closed.

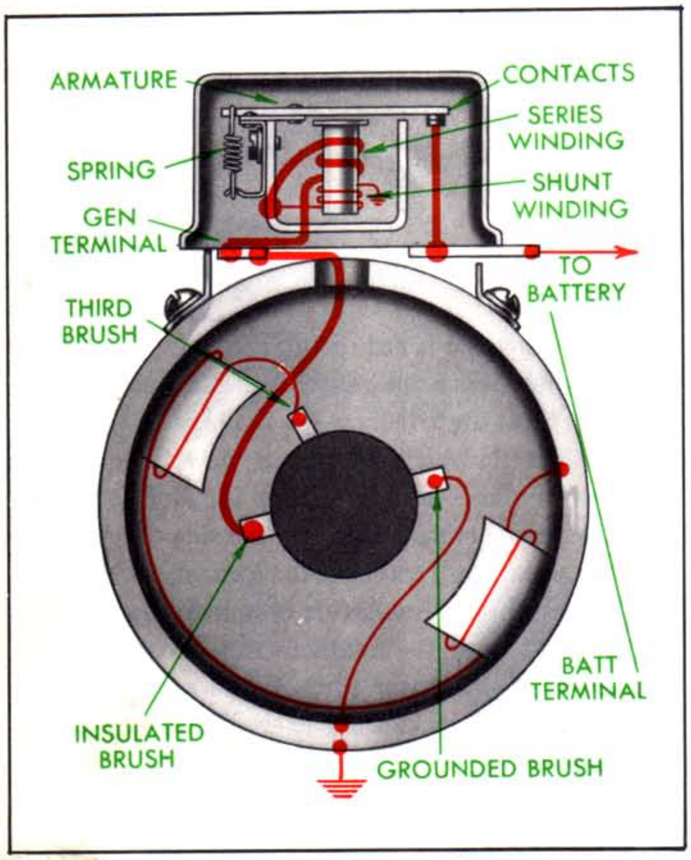


FIGURE 109—INTERNAL WIRING OF CUT-OUT RELAY AND ITS GENERATOR. When the generator begins to produce electricity, the current flows from the insulated brush to the armature terminal then through both the series and shunt coils to ground, and the magnetism created by the shunt coil pulls the armature down, closing the contacts and connecting the generator to the battery.

When the engine is slowed or stopped the generator voltage falls and when it drops below the battery voltage, current flows from the battery back through the contacts, series coil and generator. The reversed current in the series coil causes its magnetism to reverse and oppose the magnetism still produced by the shunt coil. This reduces the total magnetism to a point where the spring opens the contacts, disconnecting the generator from the battery.

This same sequence of events takes place whether the unit is mounted alone with the series coil connected directly to the armature terminal or whether the cutout really is combined with a voltage or current regulator

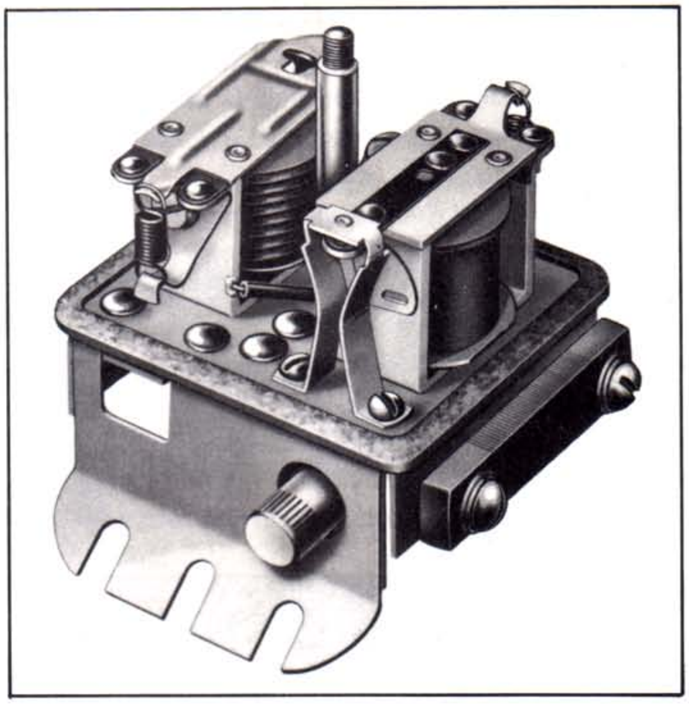


FIGURE 110—TWO CHARGE REGULATOR WITH COVER REMOVED. This unit includes a cut-out relay, similar to that illustrated in figure 108, and a two step voltage control. The voltage regulator contacts are closed when at rest and open when the winding is sufficiently energized by the circuit voltage.

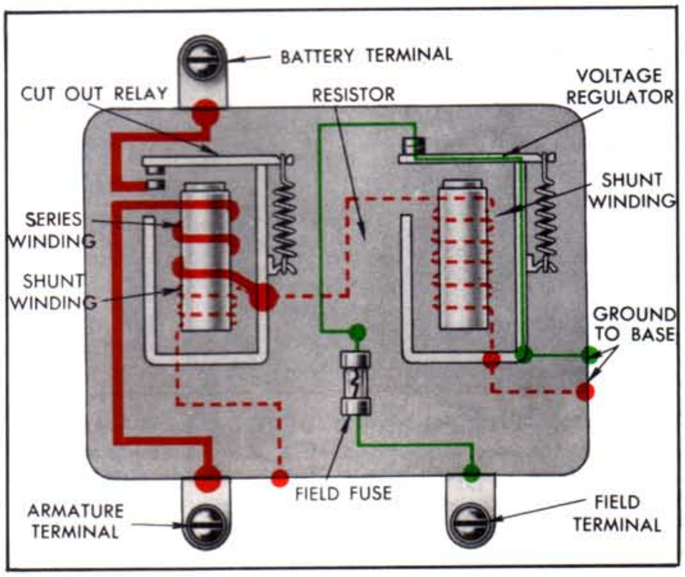


FIGURE 111—INTERNAL CIRCUITS OF TWO CHARGE REGULATOR WITH CONTACTS AT REST. In this illustration the heavy red line indicates the load or series circuit, the green line represents the field circuit, the dotted red lines show the regulator operating current and the black line indicates the circuits which are idle and carry no current.

During the build up period the units and circuits are as shown; however, when the cut-out relay shunt coil produces enough magnetism, the relay contacts close and allow current to flow from the generator to the battery. If the voltage rises further to the calibration figure of the voltage regulator unit, its contacts are opened and the field circuit changes to that shown in figure 112.

which may have additional shunt and series windings for the units and connected between the cutout relay and the regulator terminals.

TWO CHARGE REGULATOR

The two charge regulator, shown in figure 110, is used with third brush generators and reduces the generator output when the circuit requirements are not large. Usually the two charge regulator is combined on the same base with a cutout relay previously described. The regulator may have a radial mounting designed to fit on the generator frame or it may have a flat base that can be mounted on any convenient location.

The voltage regulator unit has a set of contacts that are connected in the generator field circuit so that the field circuit is completed directly to ground when the contacts are closed; while, with the contacts open, a resistor is inserted in the field circuit. See wiring diagrams in figures 111 and 112. The resistance reduces the generator field current and causes a lowered output.

One of the voltage regulator contacts is mounted on a stationary bridge while the other is mounted on a movable magnetic armature. The armature is actuated by an electromagnet which has many turns of small wire and is connected across the generator output so that the amount of the magnetism it produces depends on the voltage of the generating system. Spring tension holds the contacts together when the unit is at rest.

When the generator is stopped there is no current flowing in the cutout relay shunt coil or in the voltage regulator winding. When the generator is started, its voltage builds up and current begins to flow through both the cutout relay and voltage regulator shunt coils. When the generated voltage reaches the calibration figure of the cutout relay this unit closes and connects the gen-

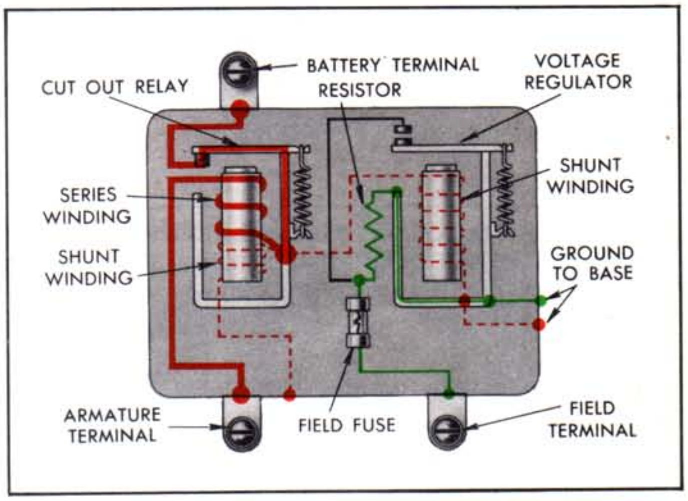


FIGURE 112—INTERNAL CIRCUITS OF TWO CHARGE REGULATOR WHILE OPERATING. This diagram is exemplified in the same manner as in figure 111 and shows the change in field circuit when the voltage regulator contacts are opened. The resistance inserted in the generator field circuit by the opening of the voltage regulator contacts, reduces the generator output by about 50%.

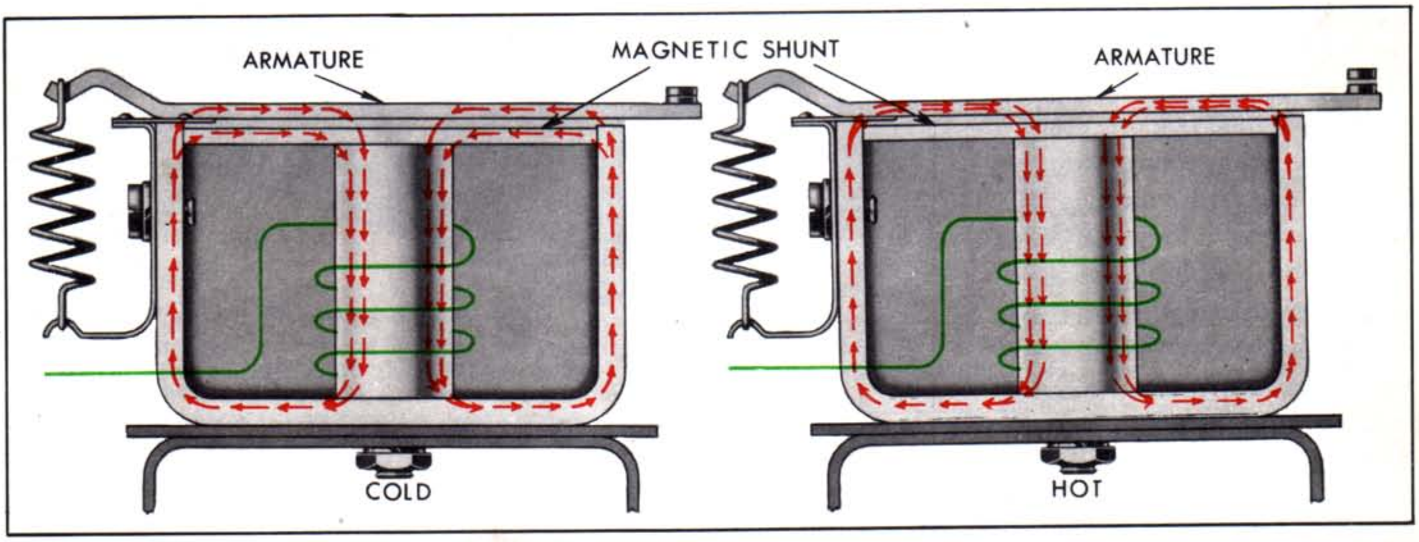


FIGURE 113—EFFECT OF HEAT ON THE MAGNETIC SHUNT USED ON MOST VOLTAGE REGULATORS. The magnetic shunt bridges the top of the yoke just below the armature and, when cold, by-passes some of the magnetism so that a higher voltage is needed to operate the armature. As the shunt becomes heated it loses its magnetic properties and all of the magnetic lines must act on the armature, thus reducing the voltage necessary to produce enough magnetism to pull the armature down and open the contacts.

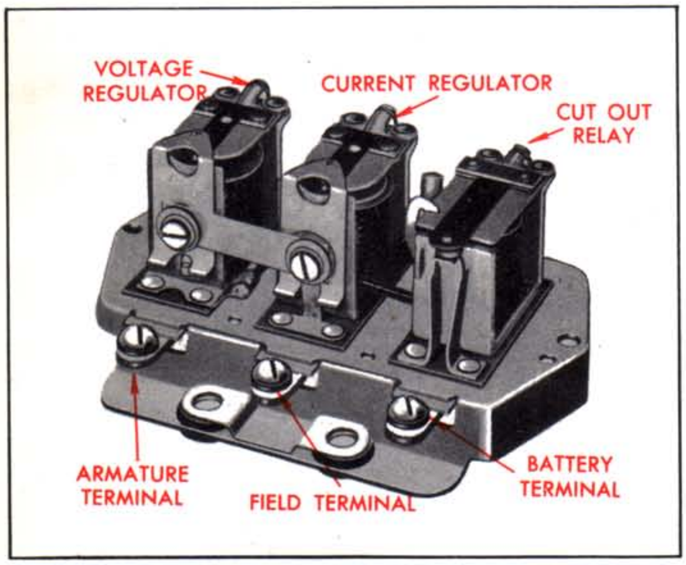


FIGURE 114—VIBRATING TYPE CURRENT—VOLTAGE REGULATOR WITH COVER REMOVED. This is the popular type regulator used with a shunt type generator on most present day cars and light trucks.

erator to the battery as previously described. The generator output continues to rise as controlled by the generator speed and the third brush position. The voltage of the system rises with the current, the amount of increase being dependent upon the battery condition and the external load then connected to the circuit. If the load is heavy or if the battery is low, the voltage will not increase very far above the cutout relay closing figure. If there is not much load and the battery is fully charged or if there is excessive resistance in the charging circuit, the voltage rises rapidly. When the voltage reaches a predetermined value, as fixed in the regulator calibration, the voltage regulator electromagnet becomes strong enough to overcome the spring tension and pull down on the armature. This opens the contacts and inserts the resistance in the generator field circuit. With the resistance in the field circuit the output is reduced by approximately 50% depending upon the value of resistance and the generator design. This decreases the system voltage and reduces the possibilities of burning out lamps and ignition contacts or of overcharging the battery. Such occurrences are still possible, however, if the reduced charging rate is still too high for the other circuit factors or if there is a poor connection between the regulator and battery.

The regulator contacts remain open and the generator charges at its reduced rate until an additional load is placed on the battery and the voltage of the system drops to a second predetermined figure. With the voltage reduced by the increased load, the electromagnet is no longer able to hold the armature down and the spring closes the contacts, shorting out the resistance and

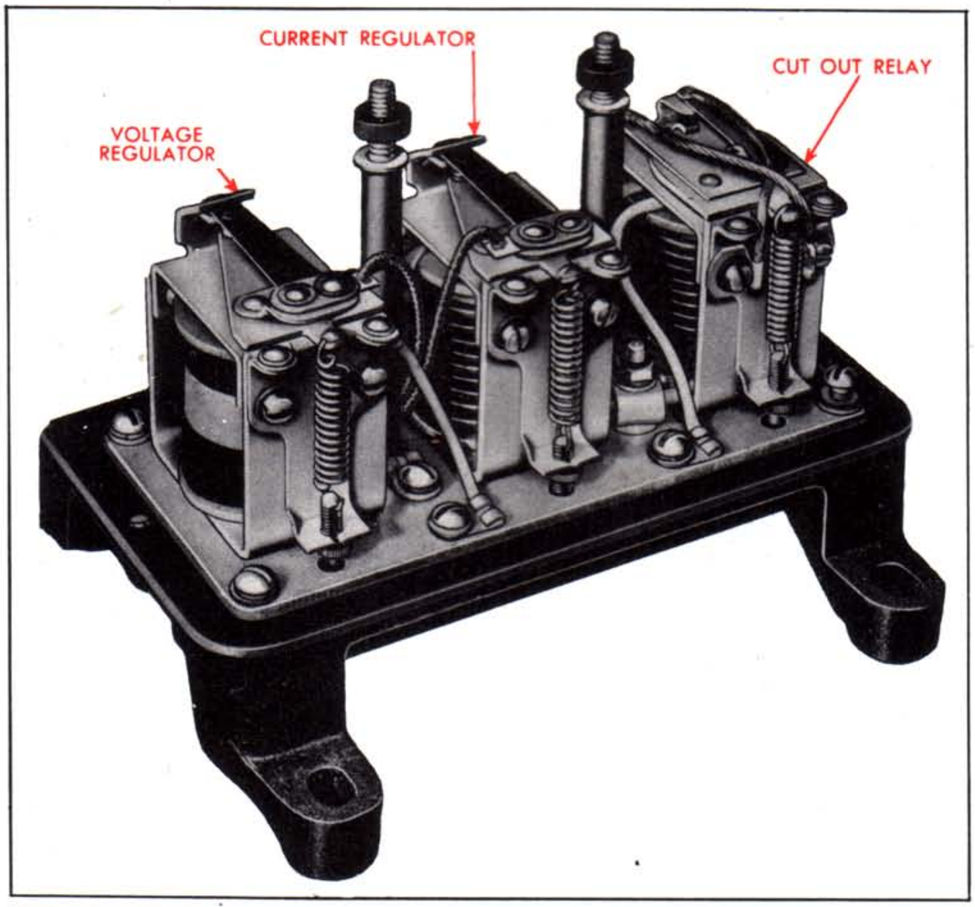


FIGURE 115—HEAVY DUTY CURRENT—VOLTAGE REGULATOR WITH COVER REMOVED. This type regulator performs the same functions as that illustrated in figure 114; however, it is designed for heavy duty applications and its construction requires slightly different connections and adjustments.

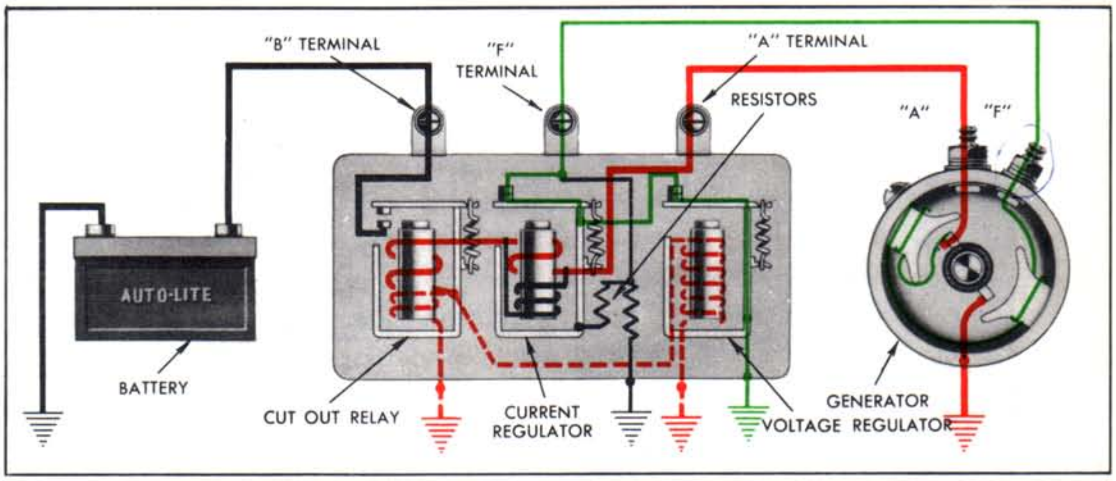


FIGURE 116—INTERNAL CIRCUITS OF VRP TYPE CURRENT-VOLTAGE REGULATOR DURING THE BUILD-UP PERIOD.

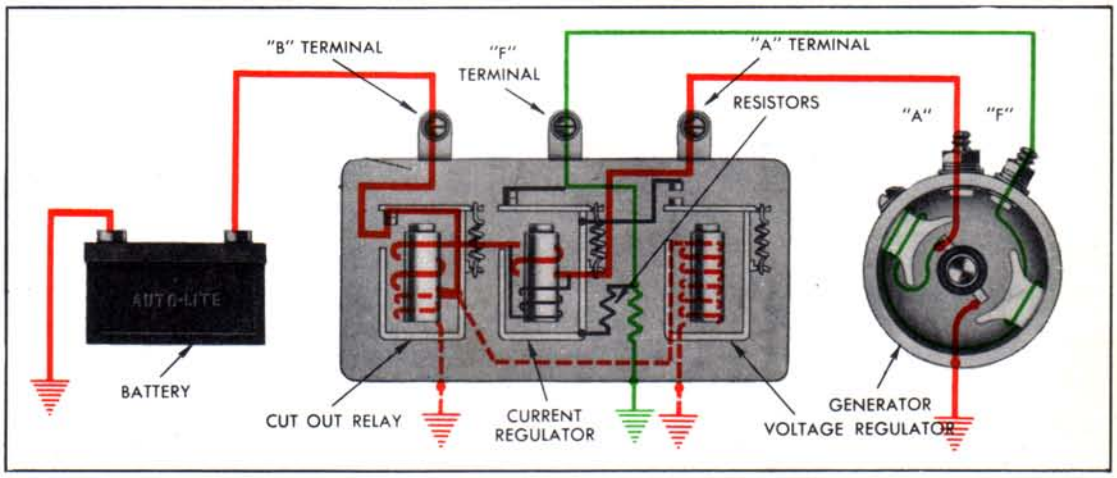


FIGURE 117—INTERNAL CIRCUITS OF VRP TYPE CURRENT-VOLTAGE REGULATOR WITH VOLTAGE REGULATOR OPERATING.

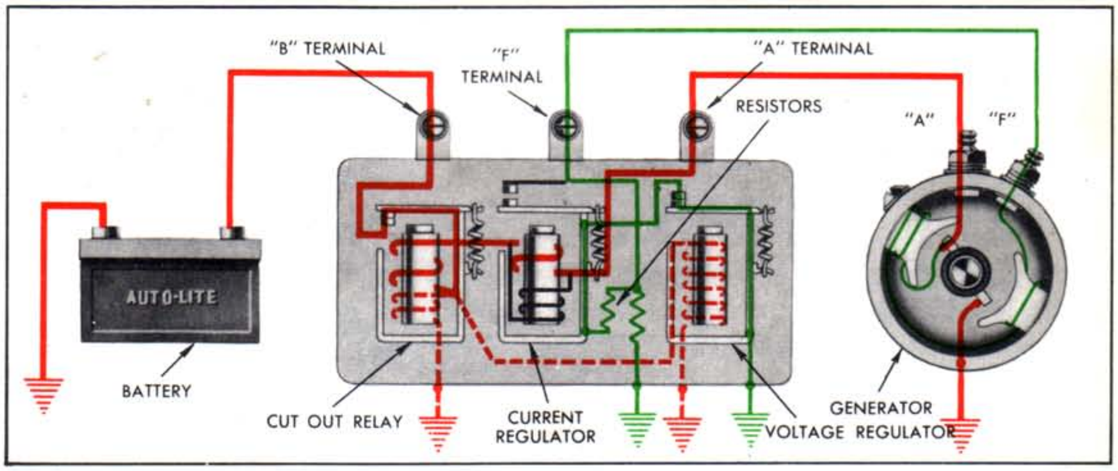


FIGURE 118—INTERNAL CIRCUITS OF VRP TYPE CURRENT-VOLTAGE REGULATOR WITH CURRENT REGULATOR OPERATING.

━━━ **SERIES CIRCUIT**
- - - - **SHUNT COIL CIRCUITS**
━━━ **FIELD CIRCUIT**
━━━ **INOPERATIVE CIRCUITS**

With the regulator contacts at rest, as illustrated in figure 116, the field circuit is grounded directly through the contacts and the generated voltage quickly builds up when the generator begins to turn. A small energizing current flows from the generator through the series windings to the cut-out relay yoke where it divides and flows through both shunt coils to ground. When the voltage reaches a predetermined value, the cut-out relay is closed by the shunt coil magnetism and connects the generator to the battery so that the output circuit is complete. If the generator speed is sufficient, the generated voltage continues to rise until it reaches the calibrated value of the voltage regulator. When this point is reached the voltage regulator contacts open and change the field circuit to that shown in figure 117. With the generated voltage reduced by the resistance in the field circuit, the voltage regulator cannot hold the contacts open and the field circuit returns to that shown in figure 116. These cycles occur at a high enough frequency to hold the output at a steady value.

If external circuit factors will not allow the voltage to build up to the regulator operating voltage, the generator output continues to rise until the current in the series coil produces enough magnetism to open the current regulator contacts. This inserts resistance in the field circuit as shown in figure 118 and the generator output falls to a point where the spring again closes the contacts. These cycles occur at a frequency high enough to limit the output with a minimum of fluctuation.

Note that on these diagrams the anti-hunt winding on the current regulator is depicted as carrying no current. Strictly this is not quite true as it is connected in parallel to the main series winding and carries a small percentage of the series current.

allowing the generator to again charge at its maximum rate.

Due to the effect of heat on the operating characteristics of the regulator windings it is necessary to compensate for changes in coil resistance when the regulator is operating under varying temperature conditions. This is accomplished through the use of a nickel-iron magnetic by-pass on the voltage regulator unit. This shunt by-passes some of the magnetic flux when the unit is cold and allows most of the flux to act on the armature when the unit is hot. See figure 113. Thus, when the coil is hot and not as efficient, the magnetic shunt reduces the amount of flux needed to attract the armature. The compensation is usually more than enough to offset the changes in regulator coil resistance due to heat. The excess compensation allows the regulator to operate at higher voltage, under cold operating conditions than under hot conditions. This is necessary as it requires a higher voltage to charge a battery with its internal resistance increased by low temperatures.

Most two charge regulators have a fuse mounted in the base which is connected in the field circuit. This fuse protects against excessive field current which in turn is a protection for the generator when an open occurs in the charging circuit and the generator voltage rises to a high value.

THE VIBRATING VOLTAGE REGULATOR

(See figures 114 and 115.)

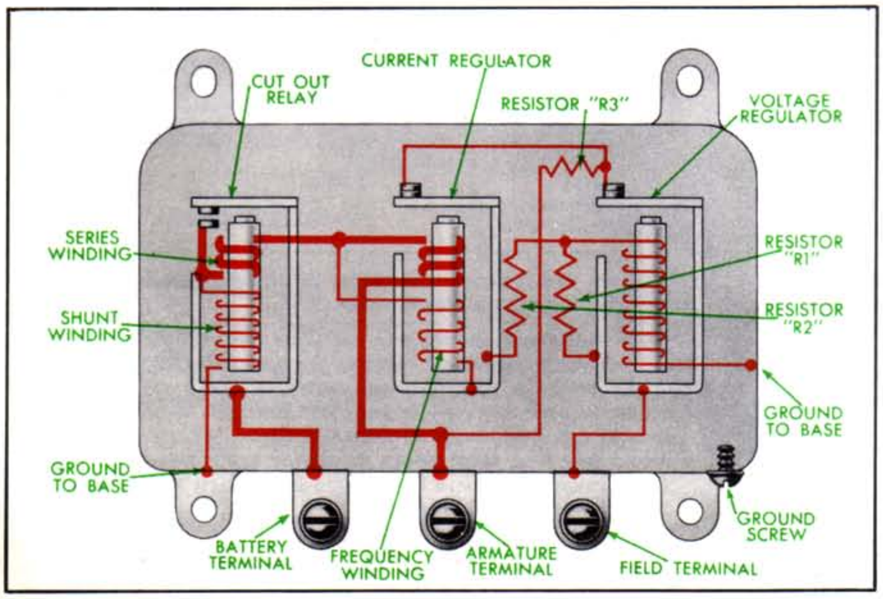


FIGURE 119—INTERNAL WIRING OF A HEAVY DUTY REGULATOR WITH RESISTORS IN THE VARIOUS CIRCUITS TO CONTROL THE VIBRATION FREQUENCY. This diagram shows the internal connections of a VRY type regulator which is typical of the type of circuit used on heavy duty units. The currents thru the various parts of the unit change a number of times during each cycle of operation of either the voltage or current regulator unit.

The vibrating voltage regulator is similar in construction to the two charge voltage regulator having the winding of small wire, movable armature, resistor and contacts. The contacts are also connected in the generator field circuit with the resistance inserted in the field circuit whenever the contacts are open. See figure 117. However, due to different mechanical and electrical values, the contacts do not remain open, but close immediately upon the reduction of the generator voltage. The voltage rises when the contacts close and the cycle is repeated. This results in a vibrating action of the armature and contacts, and the generator voltage is limited to a steady value.

The voltage regulator armature will not vibrate as long as the voltage of the system is below the calibration value of the regulator. If due to a low battery, low generator speed, or a large load, the voltage of the charging circuit does not build up to the regulator operating voltage, its contacts remain closed and the regulator is inactive. When the voltage rises to the calibrated value, the regulator starts operating and limits the voltage. While the voltage regulator is a voltage limiting device, in that it is possible to have a voltage lower than the regulated value, in actual operation whenever the voltage is high enough to operate the unit, the regulator holds the voltage constant at the calibrated figure.

On some of the heavy duty regulators it is necessary to increase the frequency of armature vibration by electrical means. A special hookup of the resistors and coils is used to accomplish this purpose. This type of hookup may use either a resistor or a winding to offset the variations in voltage caused by changes in speed or load conditions. Figure 119 shows a typical diagram of this type hookup which uses a winding on the current regulator unit together with the resistors in order to control the frequency of both the voltage and current regulators. On some types the "frequency" winding is replaced with a resistor and the hookup of the various parts may be changed.

All Auto-Lite vibrating voltage regulators are temperature compensated by a nickel-iron magnetic by-pass. This magnetic shunt has the same purpose and operates in the same way as that described for the two charge voltage regulator.

THE CURRENT LIMITING REGULATOR

Shunt type generators do not have inherent current limiting action and require some auxiliary means to limit the maximum output to a safe value. The two methods in general use are: a separate current regulator used in conjunction with a voltage regulator; or a combination such as a voltage regulator with a shunt winding over which is wound a few turns of larger wire through which the output of the generator flows.

The vibrating current regulator is constructed like the vibrating voltage regulator; the main difference being in the winding which has a comparatively few turns of large wire and is connected so that all of the generator output flows through it; making the magnetism dependent upon the current output. The current regulator contacts open when the current reaches the calibrated value and insert resistance in the generator field circuit. See figure 118. The output drops quickly and spring action closes the contacts. These cycles occur at a frequency high enough to limit the output to a steady value.

The combination unit has a few turns of heavy wire wound over the shunt winding of the voltage regulator. See figure 120. The two voltage regulator coils are wound so that when the generator output tends to increase due either to a low battery or high load, the two coils combine to increase the magnetic pull on the regulator armature, resulting in a reduced voltage, which in turn holds the generator output to a safe value.

Usually a different value of resistance is required in the field circuit when a generator is operating at its maximum output, so some regulators have a second resistor which is connected in the field circuit when the current regulator contacts are open. Due to the mechanical construction and internal hookup of the regulator, the actual resistance inserted in series with the field circuit by the current regulator may be a combination of two or more resistors connected in parallel. This only changes the value of the resistance and does not alter the fact that the field current is reduced by the resistance whenever the contacts are open.

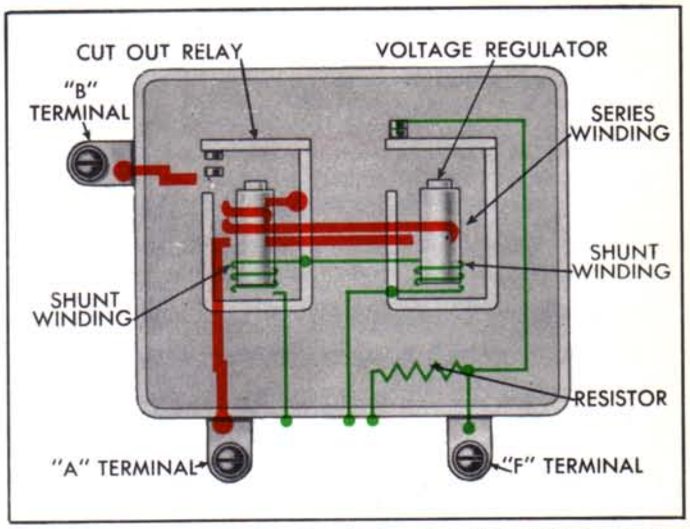


FIGURE 120—INTERNAL WIRING OF A VIBRATING VOLTAGE REGULATOR WITH A CURRENT WINDING ON THE VOLTAGE REGULATOR. This voltage regulator operates in the same manner as that illustrated in figures 116, 117, and 118 except that the current winding increases the magnetism of the voltage regulator and reduces the voltage needed to vibrate the contacts so that the regulated voltage falls as the output increases.

Like the voltage regulator unit, the current regulator used on heavy duty generators may have a second winding. This winding is either a frequency winding (Figure 119) connected in the field circuit or it may be a simple series winding connected in parallel and in opposition to the main winding. This last type, shown in the diagrams in figures 116, 117, and 118, is used to reduce hunting when the regulator is transferring from voltage to current regulator operation or vise versa.

On some recent types of current regulators, a bi-metal type armature hinge is used. This bi-metal hinge produces a variable tension on the regulator armature, due to temperature, and changes the current needed to vibrate the contacts. This gives a higher generator output under cold conditions without any change in generator design. The generator does not become overheated as it is usually the same temperature as the regulator. This compensation increases the generator capacity during cold weather when there are normally larger demands for electricity.

RECTIFIERS

Recently rectifiers have been added to the field circuit on some types of regulators. These rectifiers make an alternate, low resistance path for the field current to continue when the regulator contacts open. This limits the build-up of voltage across the contacts and reduces the arc when the contacts separate. A rectifier is used for this circuit as it has low resistance in one direction and high resistance in the other.

Two types of rectifiers have been used: Copper sulphide and selenium. Both are connected between the field and armature terminals; however, these connections are made at different points as it is necessary to connect a resistor in series with the copper sulphide type, in order to obtain best overall performance.

As the rectifier is connected from the armature terminal to ground (through the regulator contacts) it is imperative that it has the correct polarity. Always make sure the regulator is designed for the same polarity as the system before connecting the unit. Regulators designed for negatively grounded systems are conspicuously marked with raised letters on the cover. Also, whenever the battery has been disconnected or removed, it should be carefully installed for the correct polarity. If

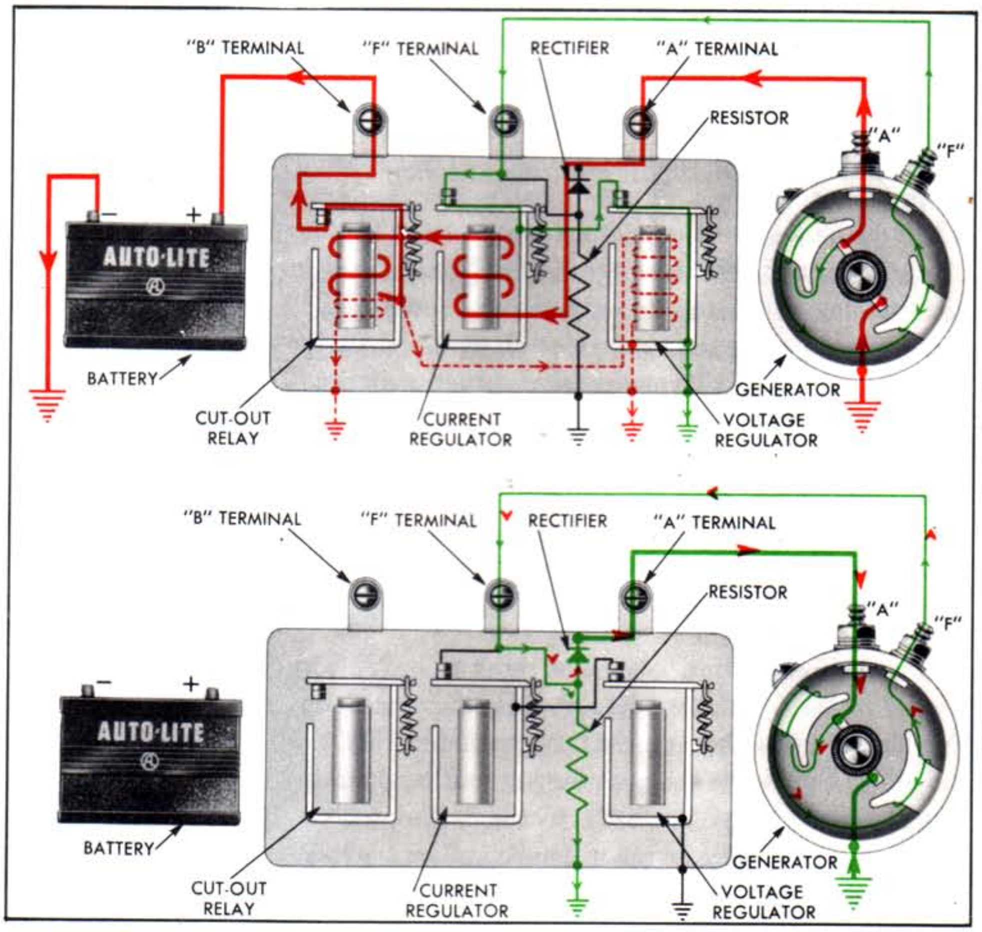


FIGURE 121—INTERNAL CIRCUITS OF A REGULATOR USING A SELENIUM RECTIFIER TO REDUCE CONTACT ARCING. In the upper view all of the contacts are closed and the generator is charging the battery. The direction of current flow is indicated by the arrows on the various wires with the heavy red lines indicating the series circuit, the dotted red lines indicating the shunt coil circuits, the green lines indicating the field circuit and the black lines indicating the inoperative circuits. Note that no current flows through the rectifier as it has high resistance in the direction in which the voltage is applied.

When either set of contacts open, the field circuit is changed to that shown in the lower view. The series and shunt coil circuits are not shown in this view as they do not change, and would confuse the indications of the field circuits. When the contacts open, the current tends to continue flowing in the generator fields due to induction. This current flows through the rectifier which makes a closed circuit as shown by the red arrows. The field current falls rapidly when the contacts open as there is no longer a direct path to ground. This lowers the generated voltage to a point where the contacts close and the cycle is repeated.

On high output units the induction of the field windings is of a high enough value to produce a very high voltage if the only passage for the field current were through the resistor to ground. This high voltage would tend to jump the gap as the contacts open and would cause an arc with resultant short contact life. The rectifier circuit provides a low resistant path for this current and allows it to dissipate at a low voltage.

These diagrams show the circuits for a negatively grounded system. For positive ground, the rectifier is reversed and all of the current flows in the direction opposite to that shown. If one of these regulators is operated on the wrong polarity there is a constant flow of current through the rectifier which would overload the unit. Also the induced currents would not be shorted out and the contacts would soon burn.

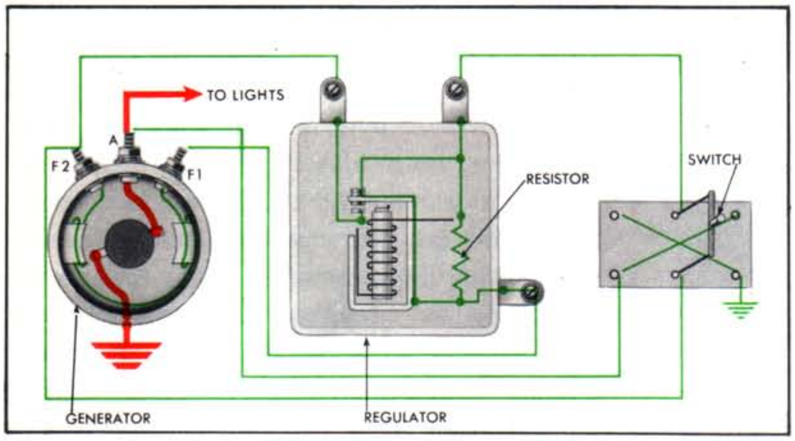
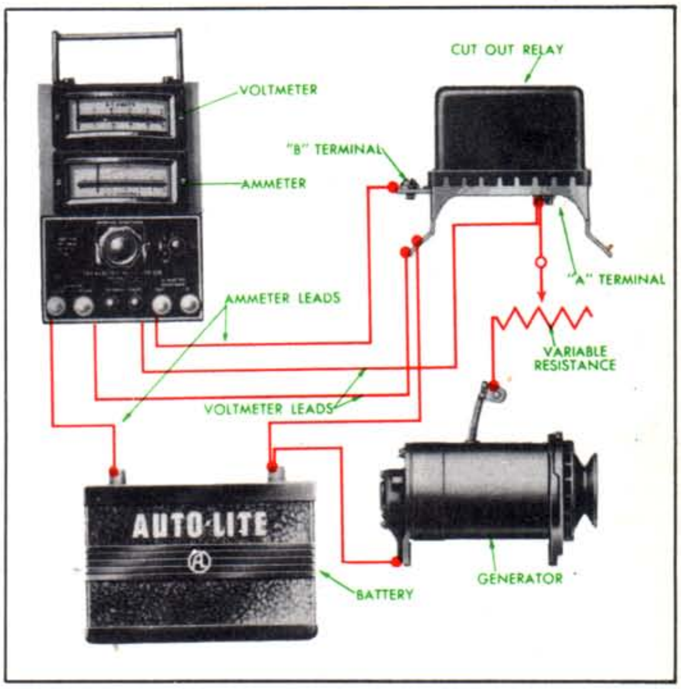


FIGURE 122—INTERNAL WIRING OF A VIBRATING VOLTAGE REGULATOR FOR USE ON BATTERYLESS CIRCUITS. This type regulator has two sets of contacts on the voltage regulator unit. At low generator speeds the resistance is cut in and out of the field circuit by the opening and closing of the upper contacts. At high generator speeds the resistor does not reduce the output enough and the increased voltage closes the lower contacts. This shorts out all field current and reduces the voltage until the lower contacts are opened by the spring.

Note that this illustration shows a reversing switch in the field circuit. This is designed for reversible generators and is not needed for generators which operate in a constant direction.

FIGURE 123—CUT-OUT RELAY TEST HOOKUP. Connect the generator to the relay and meters according to this diagram when checking the closing voltage and opening current of the relay.



the marks on the terminals cannot be deciphered use a voltmeter to determine the polarity of the battery. After installation, do not start the engine as a check on the polarity; turn on the lights and note if the ammeter moves to the discharge side.

REGULATOR RESISTORS AND CONDENSERS

While the foregoing explanations have simplified the function of the various parts of the regulator, there are other factors entering into regulator operation which affect its performance. The values of the various windings and resistors must be designed for a specific type of generator, as different field and speed characteristics or generator output, require different regulator specifications for maximum performance.

The resistors used in the regulator construction enter into some of the instantaneous circuits during the regulator cycles. For instance when the regulator contacts open, the current through the generator field is reduced. This reduction in current through the field coils, which have high inductance, generates an induced voltage much higher than the system voltage, but of short duration. It is dissipated through the resistors rather than through the arc between the regulator contacts which would cause rapid deterioration.

Sometimes additional resistors are connected in series with the various regulator windings. These resistors are inserted to produce proper function of the unit and their value or connections should not be changed.

A few of the heavy duty regulators have condensers connected internally and are specified for particular service. These also should not be altered.

Due to these various circuits and operating factors in the regulator, especially in regards to contact life, it is imperative that the resistors are not changed in value and that radio suppressor resistors or condensers are not connected to the generator or regulator field terminals. Where radio interference is excessive, install condensers from the generator or regulator armature terminal to ground. Do not install condensers on the field terminals and do not insert resistors in the charging circuit.

BATTERYLESS REGULATORS

On applications which do not use electrical starters it is sometimes desirable to have a generating system to

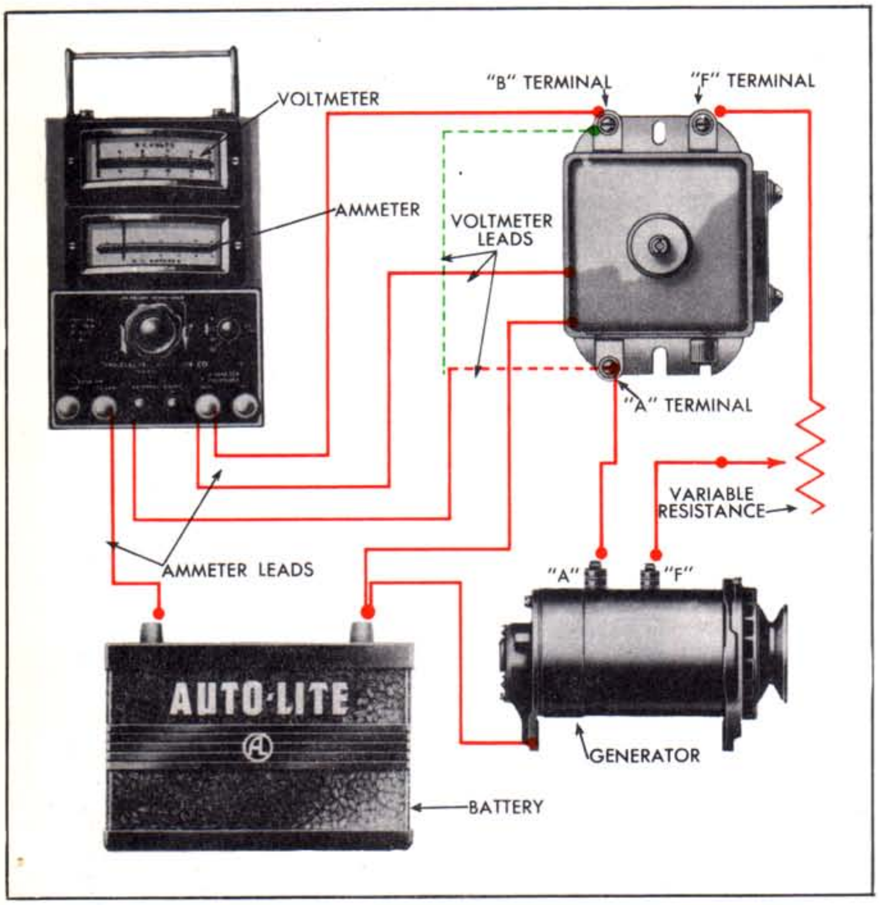


FIGURE 124—CONNECTIONS FOR TESTING A TWO CHARGE REGULATOR WITH A GENERATOR. Connect the regulator, generator, battery and meters in this manner when checking the cut-out relay opening and closing. To check the voltage regulator change the voltmeter connection from the regulator "A" terminal to the regulator "B" terminal.

operate the lights. As these usually use magneto ignition and have no starting motor, a battery is not required.

Since there is no battery to discharge through the stopped generator, a cut-out relay is not required. Also there is no necessity for a current regulator as such systems are used only for lighting and the load is constant.

Batteryless voltage regulators are similar to the vibrating voltage regulators and operate in the same manner. However, the values of the various resistances and electrical windings are designed to control the generator over a wide speed range. At high speeds there is a tendency to lose control of the voltage as the resistor does not reduce the field current to a low enough value. If the resistance is increased to take care of operation at high generator speeds, contact life is shortened and there is a noticeable flicker at low generator speeds.

Where the units must be used over a wide speed range a second set of contacts is installed on the regulator. These contacts are held open by the armature spring and are connected in the generator field circuit so that when the contacts are closed the generator field circuit is completely shorted out. See figure 122.

The light switch is connected to the generator so that when it is in the "off" position the lights are disconnected and the generator field circuit is open or the armature is grounded. When the lights are turned on, both circuits are completed and the generator produces current to operate the lights. The voltage regulator holds the voltage constant and the amount of current depends upon the number of lights in use. It is imperative that the generator is not overloaded by connecting too many lights in the circuit.

When the units are in operation, the generator voltage rises to a point where the magnetism of the coil overcomes the spring tension and pulls the armature down. This opens the upper set of contacts and inserts the resistor in the field circuit. The armature does not travel far enough to close the lower contacts at this time as the output drops as soon as the resistance is inserted in the field circuit. With the lowered output, the magnetism is reduced and the spring closes the contacts. These cycles occur at high enough frequencies to hold the voltage at a constant value and continue as long as the generator speed is low enough for the resistor to limit the voltage to the operating value. At high generator speeds the field current is too low for the resistor to reduce the generated voltage. When this point is reached the magnetism pulls the armature further down and closes the lower set of contacts. This shorts the field and the output is reduced. Spring action immediately opens the contacts and allows the output to rise to a point where the lower contacts are again closed. These cycles occur at high enough frequencies to limit the output to a minimum fluctuation.

REGULATOR MAINTENANCE

The regulator does not require periodic adjusting as it will operate satisfactorily over long periods. An occasional check of the wiring as described in the "charging circuit wiring" should be made as loose connections greatly affect the regulator operation. Also if some indication of faulty operation is present such as a low battery without known cause or an overcharged battery requiring frequent addition of water, the regulator should be checked by an experienced mechanic who has the necessary gauges and tools to properly check and adjust the unit.

A periodic observation of the charging circuit operation should be made as a check of the operation of the various units.

With all accessories and the ignition turned off, operate the starting motor for 5 seconds. Start the engine and operate at a speed to give 2500 generator R. P. M. (25 to 30 M. P. H.). The charging rate should rise to its maximum value. As the battery becomes charged the charging rate will gradually reduce, and when the battery becomes fully charged the charging rate will be only a few amperes. When this point is reached, turn on the lights or some other accessory. The generator output should increase to take care of the additional load and result in nearly no change in the current flowing into the battery. If the regulator acts in this manner and if the fluctuation of the ammeter hand is not excessive, the regulator requires no adjustment or repair.

While the foregoing description applies specifically to vibrating type regulators, two charge regulators will operate similarly except that the reduction in charging rate will not be gradual. The cut-back will be instantaneous when the battery becomes nearly charged and the final charging rate may be from 0 to 10 amperes depending upon the type of units and conditions. Also the charging rate may not increase immediately or the exact amount to take care of an added load.

In general, if the battery is kept charged except when an unusually severe load is placed upon it and if it does not require more than the usual amount of water, it is an indication that the generator and regulator are functioning in their proper manner and do not require attention.

OPERATING TESTS AND ADJUSTMENTS

These adjustments and instructions apply only to the single unit cut-out relay used with a plain third brush

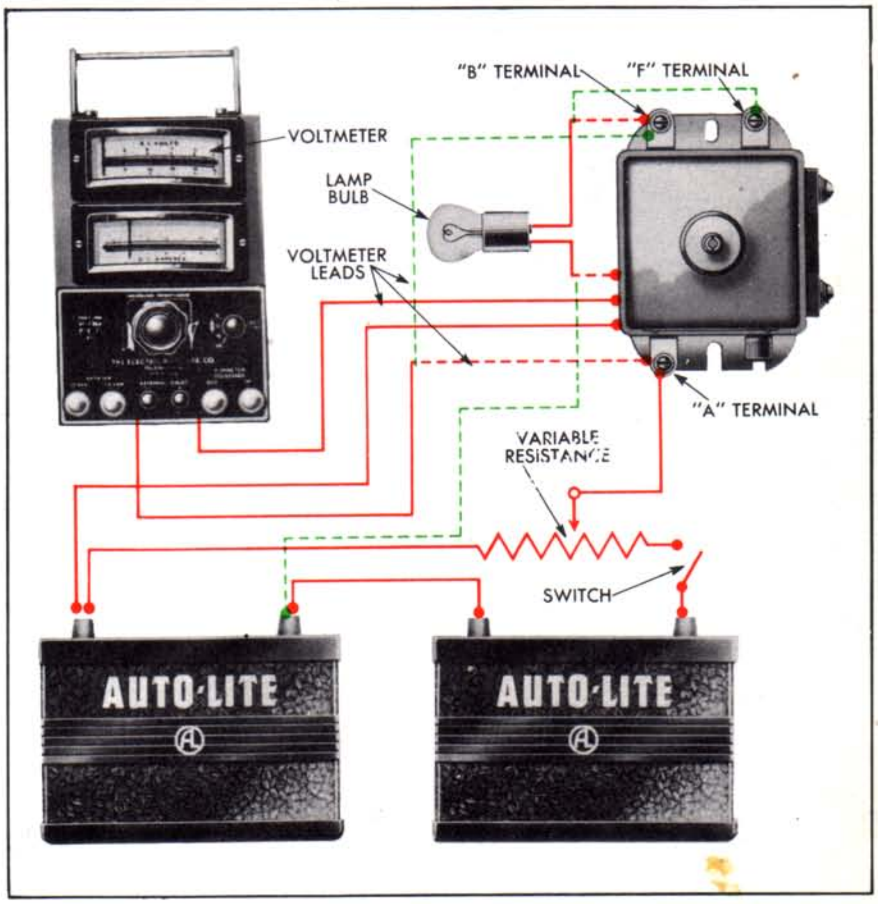


FIGURE 125—CONNECTIONS FOR TESTING A TWO CHARGE REGULATOR ON THE BENCH. A six volt battery is connected in series with a battery of the regulator rated voltage and a variable resistance or potentiometer is connected across the batteries to control the voltage applied between the regulator "A" terminal and base. To check the voltage regulator operation change the lamp and voltmeter connections as indicated by the green lines above.

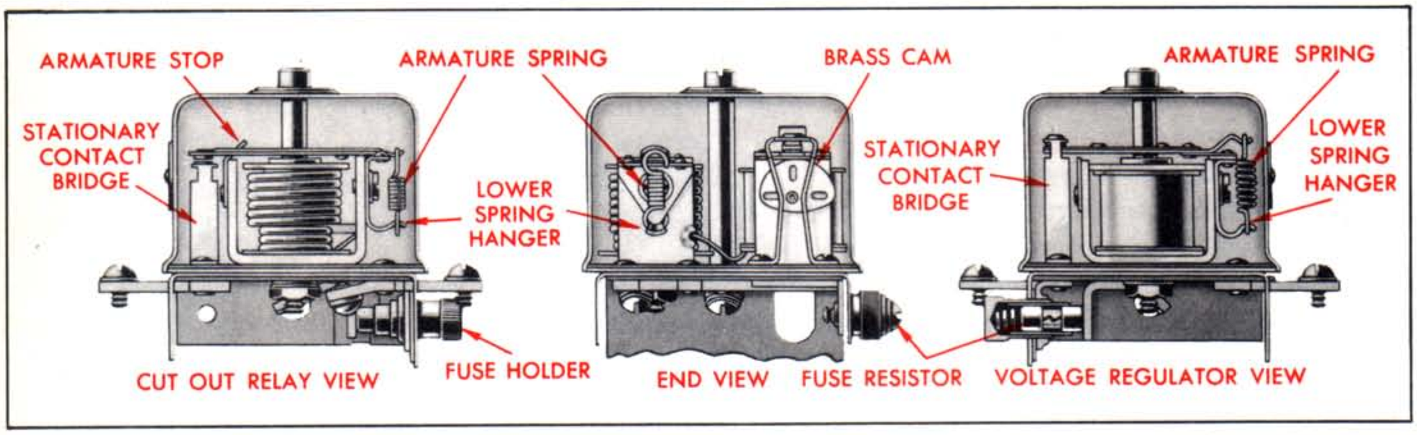


FIGURE 126—TWO CHARGE REGULATOR ADJUSTMENTS. This illustration shows the various parts which must be adjusted to obtain the correct air gaps, contact gaps, and operating voltages.

generator. For the cut-out relay combined with a two charge regulator or vibrating type regulator refer to the instructions on these types.

Remove the relay cover and inspect for evidence of high temperature, paying special attention to the insulation and windings. Inspect the contacts and if dirty, burned, or pitted, file with a No. 6 American Swiss cut equalling file. File lengthwise and parallel to the armature as shown in figure 127, until the contacts present a smooth flat surface toward each other. It is unnecessary to remove every trace of pitting.

Adjust the armature air gap by inserting a feeler gauge of the correct thickness between the core and armature as near to the hinge side of the core as is possible. Hold contacts closed and adjust the gap by raising or lowering the stationary contact. Keep the contacts aligned so that they make contact near the center. Open the contacts and adjust the contact gap to the correct value by bending the armature stop. Be sure stop does not rub against the armature and interfere with its movement. On relays designed to operate a tell-tale light there is no separate armature stop as the tell-tale stationary contact performs this function. Adjust the contact gap by bending this upper contact bracket keeping the contacts aligned.

Connect the cut-out relay "A" terminal to the generator lead and connect the "B" terminal to the battery terminal through an ammeter. See figure 123. Connect a voltmeter from the relay "A" terminal to the base. Ground the relay base, generator frame, and second battery terminal. Also ground the field terminal on generators using a control resistor in the light switch. Polarize the generator by making a momentary connection from the relay "A" to "B" terminals with a short lead. Touching the lead to the two terminals for a second or two is sufficient.

Start the generator and increase the speed slowly noting the voltage at which the contacts close. Have the cover on the unit while testing, although do not crimp in place until adjustments are completed. Adjust to the correct closing voltage by bending the lower spring hanger to increase or decrease the spring tension.

Increase the generator speed until the generator charges about ⅔ of its maximum rate then reduce the generator speed noting the amperage discharge just before the contacts open. Adjust the opening amperage by raising or lowering the stationary contact. Keep the contacts aligned and do not adjust the contact gap to less than .015 inch.

Replace the relay cover and gasket and clinch the ears so that the cover is firmly in place then recheck the cut-out relay closing and opening.

If the cut-out relay cannot be adjusted within specifications it is an indication of an open or grounded shunt coil or some mechanical damage and the relay should be replaced.

TWO CHARGE REGULATOR

If there is some indication that the regulator is not operating correctly, its operation should be checked using accurate meters. Do not attempt to check or adjust the regulator without the correct tools and meters as a variation of only 0.1 volt in the setting may be enough to cause overcharged or run down batteries.

Due to the different characteristics in the various makes and sizes of batteries they may become overcharged when the equipment is operated consistently in hot climates even though the regulator may be set according to specifications. When, after checking the settings, such a condition is found, the regulator should be readjusted 0.1 volt below the specified settings.

OPERATING TEST AND ADJUSTMENTS

To test and adjust the regulator on the generator either on bench or engine, connect a variable resistance between the regulator field terminal (marked "F") and the generator field lead. When the regulator is mounted on the generator it is necessary to remove the mounting screws and lift the regulator to expose the terminal. Be sure to re-install some of the mounting screws before testing as the regulator must be grounded to the generator. Connect an ammeter between the regulator battery terminal (marked "B") and the lead removed from the terminal. Connect a voltmeter from the regulator armature terminal (marked "A") to the regulator base. See figure 124. Make sure all other connections and leads in the charging circuit are tight and in good condition. Start the generator and turn the field resistance to "all out", then operate the generator at 10 amperes output for 15 minutes to bring the units up to operating temperature. Occasionally, when the regulator is severely out of adjustment it is necessary to make a preliminary setting of the operation before the units can be operated for this warm-up period. If no charging rate is obtained when the generator is operated at a medium speed, make adjustments as described below then replace the regulator cover and proceed with the above warm-up.

To test and adjust the regulator on the bench connect a six volt battery in series with a battery of the regulator rated voltage and connect a potentiometer or slide wire rheostat (3 Amp.—50 Ohm Capacity) across the battery terminals. Connect the regulator base to the ground end of the potentiometer and connect the variable potentiometer terminal to the regulator "A" terminal. Connect a voltmeter between the regulator "A" terminal and the regulator base. Connect a 3 C.P. lamp of rated voltage between the ground end of the potentiometer and the regulator "B" terminal. See figure 125. Place cover on regulator and adjust the voltage to 6.3 volts for a 6 volt regulator or 12.5 volts for a 12 volt regulator. Allow to stand in this manner for 15 minutes to warm the regulator.

Turn the variable resistance so that the voltage is reduced as low as possible then slowly increase the voltage, noting the cut-out relay closing voltage just before the jump in the voltmeter reading on the first method or by the lamp lighting on the second method. Adjust the closing voltage to the specified value by bending the lower spring hanger to change the armature spring tension. See figure 126. Replace the regulator cover before checking the setting.

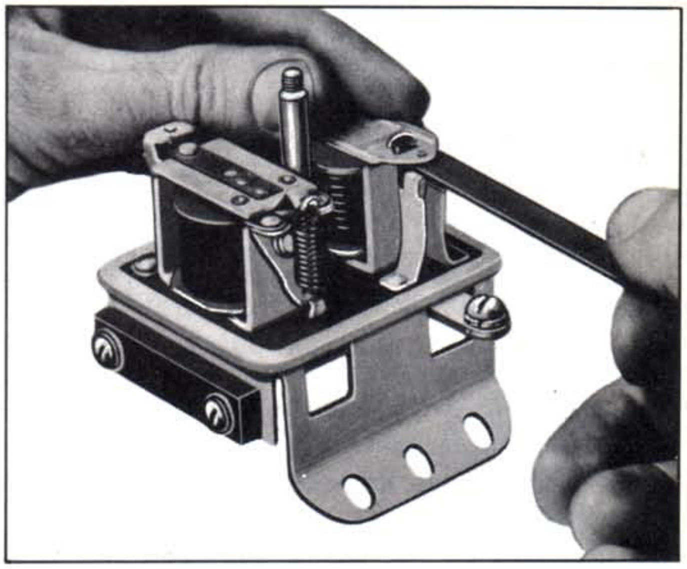


FIGURE 127—FILING THE CUT-OUT RELAY CONTACTS WITH A VERY FINE EQUALLING FILE. Hold contacts so there is a slight pressure on the file and move the file lengthwise and parallel to the armature. Do not file crosswise as this forms minute grooves that may cause sticking. It is unnecessary to file away all pits; however, all scale and projections should be removed.

When checking with the battery and potentiometer method it is not possible to adjust the opening current. When checking on the generator, however, reduce the variable resistance to give a charging rate of ⅔ maximum capacity then increase the resistance slowly, noting the amperage discharge just before the cut-out relay opens and the ammeter reading drops to zero. Adjust the opening current by raising or lowering the stationary contact keeping the contacts aligned. See figure 126. Do not adjust the contact gap to less than .015 inch.

Change the voltmeter connection from the "A" terminal to the "B" terminal and on the second method above change the lamp connections to the "hot" terminal of the battery and the regulator "F" terminal. See green lines in figure 125.

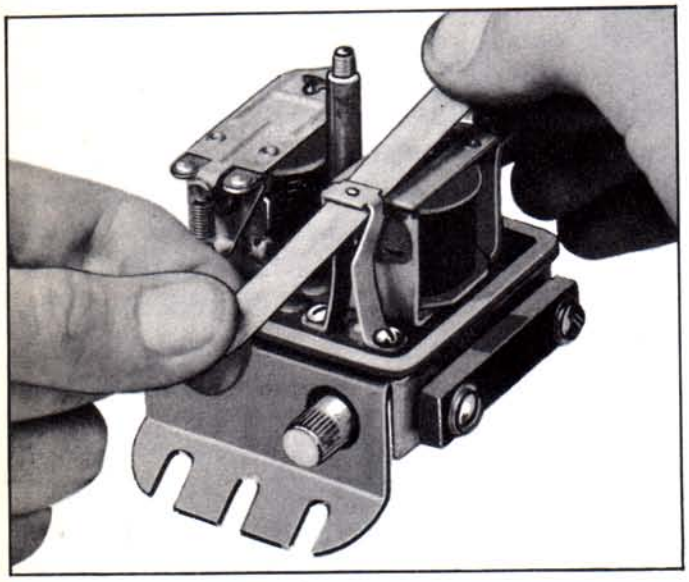


FIGURE 128—CLEANING CONTACTS WITH LINEN TAPE AND CARBON TETRACHLORIDE. Dampen the tape with carbon tetrachloride and rub the contacts briskly. Repeat with clean dry tape to remove any residue.

Increase the voltage slowly until the cut-out relay closes. Increase the voltage further noting the voltage at which the regulator contacts open and the lamp goes out or the charging rate drops back. Decrease the voltage slowly and note the voltage when the contacts close. The opening and closing voltages should be within the limits specified. To adjust the contact opening voltage change the armature spring tension by bending the lower spring hanger. Adjust the closing voltage by turning the brass cam on the contact side of the yoke. This changes the contact gap which should not be less than .005 inch minimum.

After all adjustments are completed apply one drop of air drying varnish to the cam to prevent slipping.

Replace the regulator cover and check the settings of the cut-out relay and voltage regulator and make whatever readjustments are necessary.

MECHANICAL TESTS AND ADJUSTMENTS

If the regulator cannot be adjusted to its correct operating limits make the following checks and adjustments:

1. Remove the regulator cover and inspect visually for:
   a. Evidence of burning or abnormal high temperature at the coils, contacts, insulation, external terminals or any other point.
   b. Loose connections resulting from poor soldering.
   c. Loose nuts on the bottom of the magnet cores, loose rivets or screws. All nuts and screws must have lockwashers.
   d. Broken or altered carbon resistor.
   e. Blown or improperly installed fuse. When replacing the fuse do not use a fuse substitute.

2. File the contacts with a very fine contact file so that all deposits and corrosion or dirt are removed. File lengthwise and parallel to the armature as shown in Figure 127 as crosswise filing forms minute grooves that tend to cause sticking when in operation.

3. Clean the contacts with linen or lintless bond tape and carbon tetrachloride. First draw a strip of tape dampened with the carbon tetrachloride between the contacts then follow with dry tape to remove any residue. See Figure 128.

4. Remove the carbon resistor and check its resistance on an ohmmeter. Replace it if not within specifications.

5. Adjust the gap between the core and armature on the cut-out relay. Place gauge as near to the hinge side of the core as possible and hold the armature down. Raise or lower the stationary contact to give the correct gap. See figure 126. Keep the contacts aligned.

6. Adjust the contact gap on the cut-out relay by bending the armature stop. Be sure the stop does not rub against the armature and interfere with its movement.

7. Adjust the gap between the core and armature on the voltage regulator unit. Have spring tension on the armature and the contacts closed. Insert the gauge between the core and armature and adjust the gap by expanding or contracting the stationary contact bridge. Keep contacts aligned.

8. Check the contact gap on the voltage regulator by holding the armature down and measuring the gap between the contacts with a feeler gauge. This gap

should be at least .005 inch and is adjusted by turning the brass cam on the contact side of the yoke.

9. Adjust the operation as previously described.

VIBRATING TYPE REGULATORS OPERATING TEST AND ADJUSTMENTS

These adjustments can be made either on the engine or vehicle or with the generator and regulator mounted on the test bench. Do not attempt to adjust the regulator unless its operation is thoroughly understood and accurate meters are available. Even a slight error in the settings of the unit may cause improper functioning and result in run-down or over-charged batteries.

Before any checks or adjustments are made, the wiring in the charging circuit should be inspected, tested and tightened as described in another part of this chapter. Make sure the units are correctly hooked up and check the ground polarity of the battery. Consult the regulator specifications for the correct polarity as regulators must not be used on systems with the polarity opposite to that for which they were designed. Most regulators have different material for the contacts in each set. Reversing the polarity of the system reverses the direction of the current flow and causes transfer of material from one contact to the other. Also on some of the high output units using a rectifier in the field circuit, incorrect polarity would make the regulator inoperative.

Check the part numbers stamped on the name plates of the generator and regulator to make sure the correct regulator is installed. Regulators are designed for use with a generator having a specified field draw, output, internal connections and speed range, and may not function properly if an incorrect substitution is made.

Measure the specific gravity and voltage of the battery and inspect it as described in the battery section of this chapter. An old battery, one partially charged or one subjected to excessive heat will cause high charging rate while one subjected to excessive cold, hard plates, high resistance separators or sulphation will cause low charging rate. If the battery is not up to specifications substitute temporarily for test purposes a fully charged battery in good condition of the same type and capacity.

Make sure the generator operates correctly without the regulator in the circuit. Remove the armature and battery leads from the regulator and connect an ammeter between them. This will cause a discharge through the generator and the engine should be immediately operated at idle speed. Remove the field lead from the regulator and, while operating at idle speed, touch the field lead to the regulator base (touch the field lead to the regulator terminal on all of the large, heavy duty type regulators). Increase the speed slowly noting the charging rate. DO NOT INCREASE THE OUTPUT ABOVE THE RATED OUTPUT OF THE GENERATOR. If the generator output will not build up inspect the wiring for shorts, opens, and incorrect connections and remove the generator for an overhaul. Reconnect the leads to the regulator.

Make a voltage drop test of the wiring as described in the charging circuit wiring and eliminate all high resistance.

TEST PROCEDURE

Cut-out relay (end unit—with heavy wire winding). Connect a reliable ammeter in series with the regulator

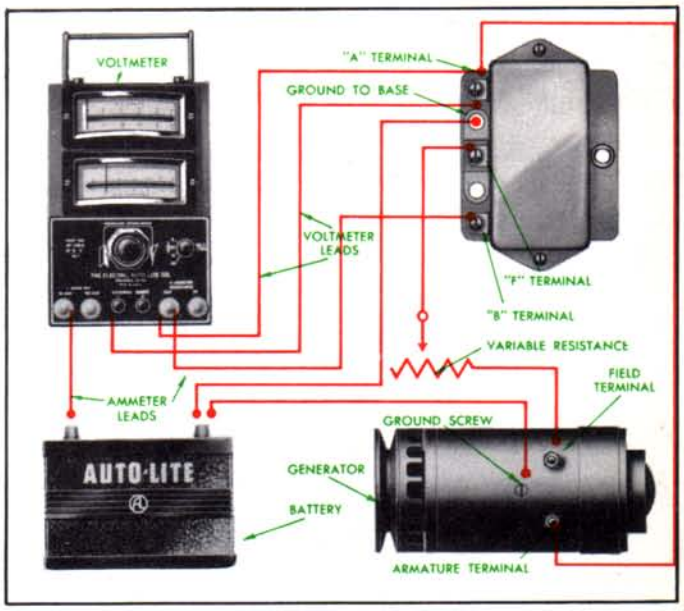


FIGURE 129—REGULATOR TEST CIRCUIT—CUT-OUT RELAY TEST. Make these connections to measure the cut-out relay closing voltage and opening voltage or current. Adjust the variable resistance to increase the voltage and note the readings just before contacts close. Be sure to connect the battery for the correct ground polarity and polarize the generator before beginning the test.

"B" terminal and the lead removed from the terminal. Connect an accurate voltmeter from the regulator "A" terminal to the regulator base and place a reliable thermometer near the regulator (about 2 inches from the regulator cover, but not touching the regulator.)

Disconnect the field lead from the regulator "F" terminal and insert a variable resistance (3 amp.—50 ohm capacity) between the lead and the regulator terminal. See figure 129.

Run the generator at about 1000 generator R. P. M. Insert all the resistance in the field circuit, then slowly reduce the resistance noting the voltage reading just before the change caused by the closing of the cut-out relay. Increase the charging rate to the figure specified for the regulator being tested then reduce the charging rate by inserting resistance in the field circuit. Note the voltmeter and ammeter reading just before the cut-out relay opens and the ammeter reading drops to zero. The closing voltage and the opening voltage or current should be within the limits specified.

An accurate method for noting the exact instant of opening or closing of the cut-out relay is to connect a headphone (2000 ohms or higher) to the battery and armature terminals of the regulator. When the contacts open or close, a click will be heard in the headphone.

To adjust the closing voltage, change the armature spring tension by bending the hanger at the lower end of the spring on the smaller types or by turning the adjusting nut on the larger types. Increase the spring tension to raise the closing voltage or decrease the tension to lower the voltage. See figure 130. To adjust the opening voltage raise or lower the stationary contact keeping the contacts perfectly aligned. Increasing the contact gap lowers the opening voltage. Change the contact gap, by expanding or contracting the stationary contact bracket as shown in figure 131, keeping the contacts aligned. Do not adjust the gap between the contacts to less than the specified minimum.

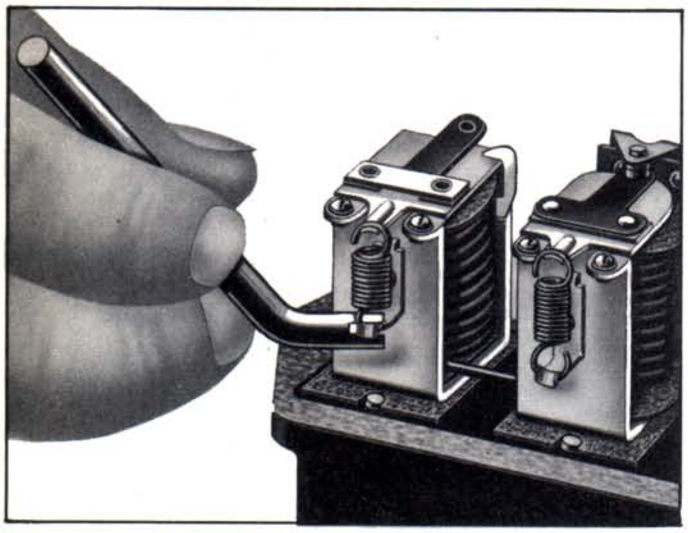


FIGURE 130—ADJUSTING CUT-OUT RELAY CLOSING VOLTAGE. The slot in the end of the tool is placed over the lower spring hanger and the hanger bent slightly to change the setting. Increasing the tension raises the closing voltage.

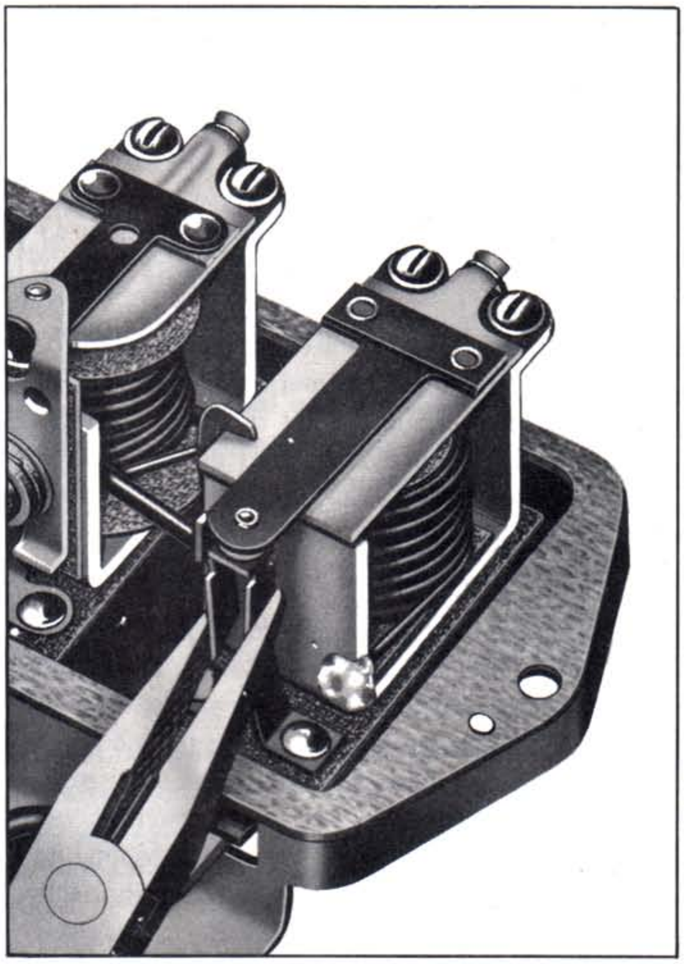


FIGURE 131—ADJUSTING THE CUT-OUT RELAY CONTACT GAP. Adjust the gap by expanding or contracting the stationary contact bridge keeping the contacts aligned. Increasing the contact gap lowers the opening voltage and raises the opening reverse current. Do not adjust the contact gap to less than the minimum specified.

Voltage Regulator (end unit—fine wire winding). Connect the ammeter as noted above and connect the voltmeter from the regulator "B" terminal to the regulator base. Remove the variable resistance from the field circuit. See figure 132.

Run the generator at ½ maximum output for 15 minutes to make sure the regulator is at normal operating temperature. Have the cover on the unit during this warm-up period and when taking readings.

Stop the engine then bring it up to approximately 2500 generator R. P. M. Adjust the amperage to ½ maximum output by turning on lights or accessories and then note the voltmeter reading. This reading should be within the limits specified for the voltage regulator operation. To adjust the operating voltage, change the armature spring tension by bending the hanger at the lower end of the armature spring or by turning the adjusting nut. After each adjustment stop the engine then restart it. Bring it up to speed and adjust the current before taking a reading.

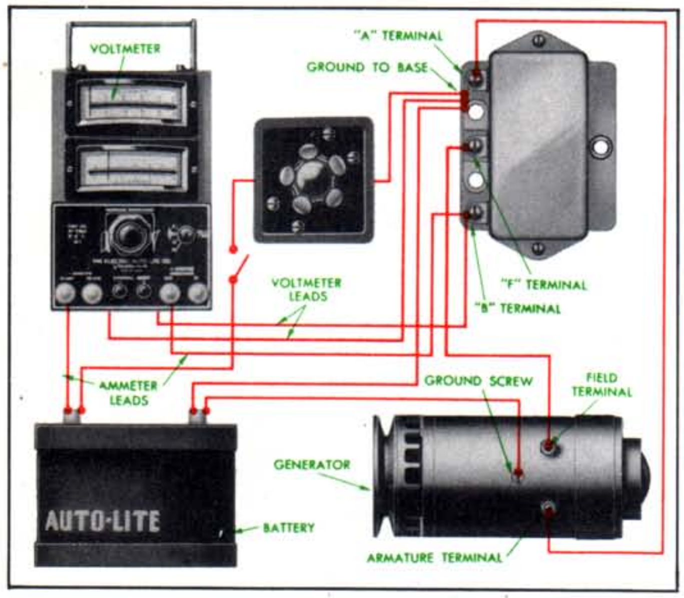


FIGURE 132—REGULATOR TEST CIRCUIT—VOLTAGE AND CURRENT REGULATOR TESTS. This circuit is similar to figure 129 except for the control rheostat and voltmeter connections. Also be sure the ammeter has sufficient capacity to handle the test current.

When testing batteryless type regulators the same procedure is followed except that the load is adjusted by turning on lights. Most types are adjusted at full load, while those having the double sets of contacts are tested at two different loads and generator speeds. See the test specifications for the correct load figures.

In order to obtain an accurate indication of the operation of the voltage regulator unit connect a headphone (2000 ohms or higher) between the "F" terminal and ground to pick up the sound of the opening and closing of the contacts. The clicks should be regular and clear without irregularities or missing. If the tone is not clear and regular remove the regulator cover and inspect the contacts. The contacts should be flat and not burned excessively and should be aligned to make full face contact. If the contacts need cleaning refer to paragraph 4 for the method.

Current Regulator (center unit—with heavy wire winding).

Connect the regulator and instruments as described above for the voltage regulator (paragraph 2) and run the generator at approximately 3000 generator R. P. M. Turn on lights and accessories so that the generator must charge at its maximum rate. The ammeter should show a reading within the limits specified. To adjust the operating amperage change the armature spring tension by bending the hanger at the lower end of the armature spring or by turning the adjusting nut on heavy duty types. After each adjustment stop the engine then restart it. Bring the engine up to speed and take an ammeter reading. Have the cover on the unit.

Temperature compensated current regulators are tested in the same manner except that the reading will vary depending upon conditions. The test figures give the specified setting after a 15 minute run at 10 amperes while operating on the voltage regulator. It should be set to this figure after the voltage regulator test. To check the setting, operate on the current regulator for 15 minutes by turning on lights or accessories to bring the voltage .3 to .5 volt below the voltage regulator operating figure. After 15 minutes operation at full load, the current setting should be within the limits of the lower specifications for the current regulator. It is recommended that the regulator setting always be checked after the full ½ hour run because the heat conditions cannot be accurately controlled during a voltage check and adjustment.

In order to obtain an accurate indication of the operation of the current regulator unit connect a headphone (2000 ohms or higher) between the regulator "F" termi-

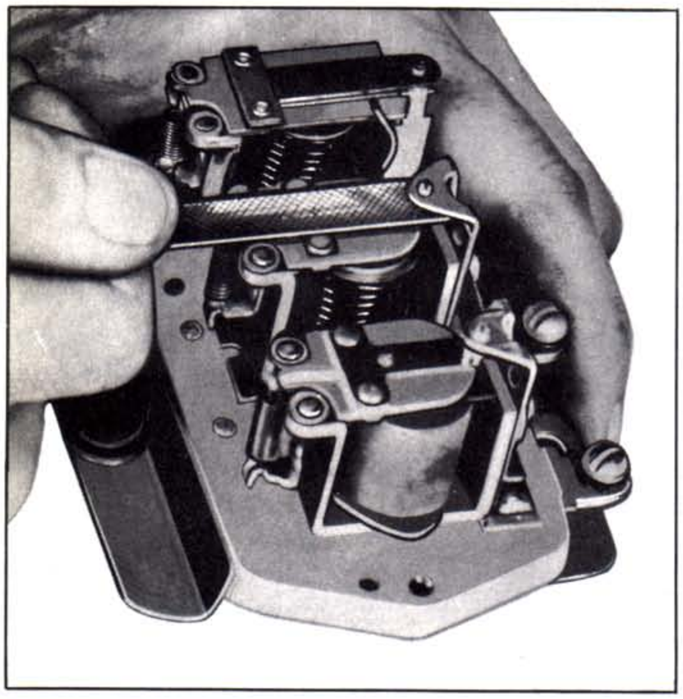


FIGURE 133—FILING CURRENT REGULATOR CONTACTS WITH A VERY FINE EQUALLING FILE. File lengthwise and parallel to the armature as crosswise filing forms minute grooves that may cause sticking as the contacts make their sliding contact. It is unnecessary to remove all cavities; however, all scale and projections should be filed smooth.

nal and ground to pick up the sound of the opening and closing of the contacts. The clicks should be clear and regular without irregularities or missing. If the tone is not clear and regular remove the regulator cover and inspect the contacts. The contacts should be flat and not burned excessively and should be aligned to make full face contact. If the contacts need cleaning refer to paragraph 4 for the method.

4. **Contacts.**

Inspect the contacts on all three units. In normal use the contacts will become grayed. If the contacts are burned or dirty or if they are not smooth, file the contacts with a No. 6 American Swiss cut equalling file as shown in figure 133. Move the file parallel and lengthwise to the armature, as crosswise filing may form grooves which would tend to cause sticking and erratic operation. File just enough so that the contacts present a smooth surface toward each other. It is not necessary to remove every trace of burning. After filing, dampen a piece of linen or lintless bond tape in refined carbon tetrachloride and draw the tape between the contacts. See figure 134. Repeat with a dry piece of tape. Use clean tape for each set of contacts.

5. **Recheck.**

Operate the unit at ½ maximum output for 5 minutes with the cover on the regulator. Repeat the testing procedure for all units as described in paragraphs 1, 2, and 3 above. Be sure cover is on regulator when taking readings.

MECHANICAL TESTS AND ADJUSTMENTS

If the regulator cannot be adjusted to the correct specifications it should be removed and the following tests made with the proper equipment. Do not attempt these adjustments without the correct gauges and tools as many of the mechanical adjustments are very critical and greatly affect the regulator performance.

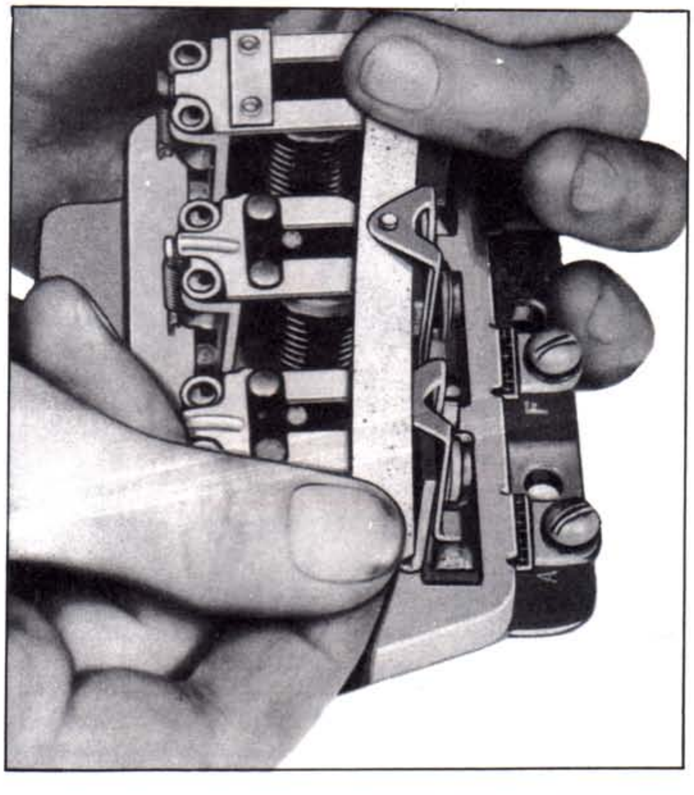


FIGURE 134—CLEANING CURRENT REGULATOR CONTACTS WITH LINEN TAPE AND CARBON TETRACHLORIDE. Do not clean the contacts unless they have first been filed as the slight roughness of used contacts will cause lint to collect which would form carbon deposits and poor contact.

Visual Inspection.

Before making any of the following tests or adjustments it is recommended that a close visual inspection be

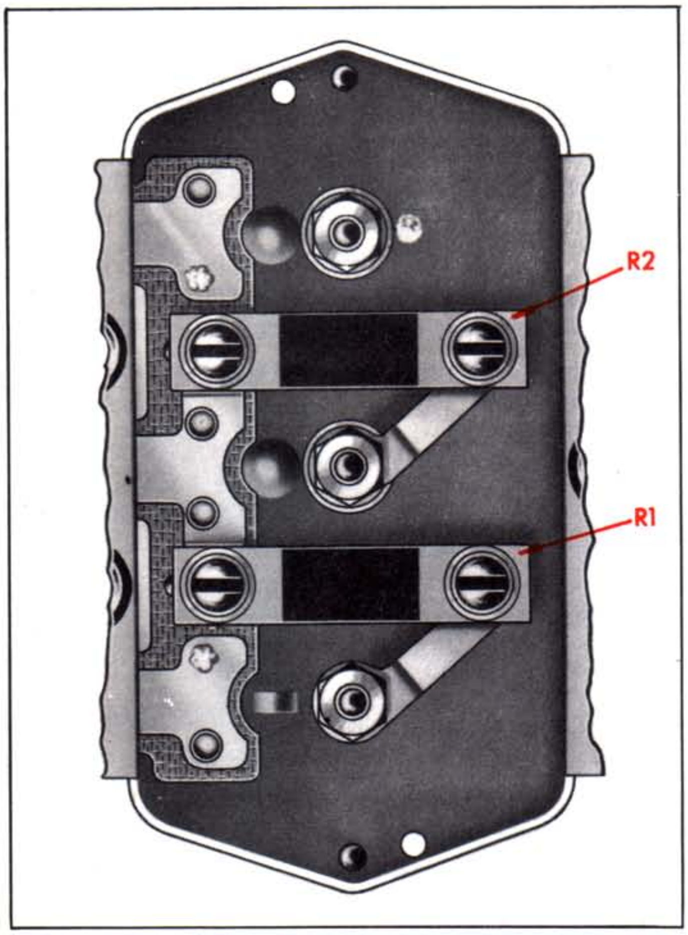


FIGURE 135—RESISTOR ASSEMBLY ON MOST CURRENT-VOLTAGE REGULATORS. Care must be exercized that the resistors are not interchanged as this would cause rapid contact failure.

given the regulator with special emphasis being paid to the following points:

1. Evidence of burning or abnormal high temperature at the coils, contacts, insulation, contact springs, external terminals or any other point.

2. Loose connections which result from poor soldering.

3. Loose nuts on bottom of the magnet cores, loose rivets or screws. All nuts and screws must have lockwashers.

4. Loose contacts.

5. Misalignment of contacts.

6. Armature stop rubbing against or interfering with the cut-out relay armature.

7. Bent armature either at the contact or hinge end. (The armature should be perfectly straight from one end to the other.)

8. Field yoke bent.

9. Bent or distorted armature hinges.

10. Reversed bi-metal hinges on the cut-out relay unit and temperature compensated current regulator unit. (When correctly installed the brass side must be up.)

11. Stripped or crossed threads on any screw or nut.

12. Corrosion due to salt or acid.

13. Evidence of water having been inside of cover.

14. Incorrect, bent, or distorted armature springs. (In case of doubt it is recommended that the spring be replaced.)

15. Broken or altered resistors.

16. Broken gaskets.

17. Incorrect wiring connections between units.

18. Reversed armature springs.

19. Broken or corroded ground strap.

Resistance Tests.

1. Resistors (See figures 135, 136 and 137).

Remove the sub-base on heavy duty units. (See figure 138.)

Remove the resistors one at a time and check with an ohmmeter. Replace resistors if cracked or not within specifications.

It is extremely important that the resistors be replaced in their proper position.

2. Shunt Coil Resistance.

On heavy duty regulators the shunt coil ground connections are disconnected when the sub-base mounting screws are removed. On this type, measure the resistance of the shunt coils separately by connecting to the two leads of each coil.

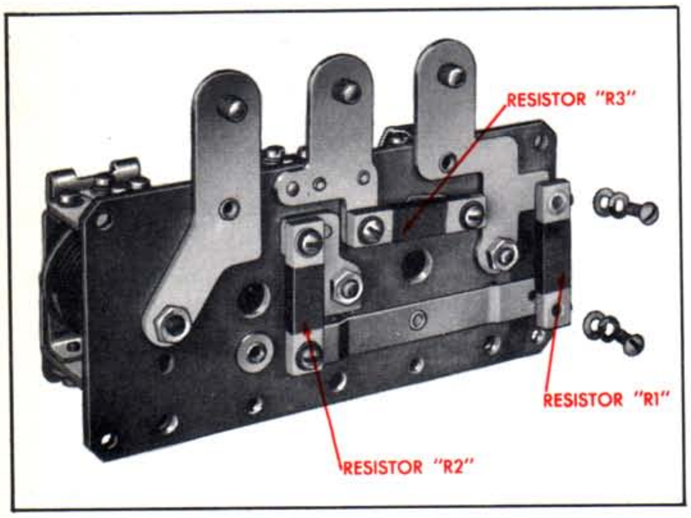


FIGURE 136—RESISTOR ASSEMBLY ON MOST HEAVY DUTY REGULATORS. Resistors should be removed one at a time and checked for cracks and correct resistance. Each resistor is stamped with a figure representing its resistance in ohms. Allowable variation is ±5%.

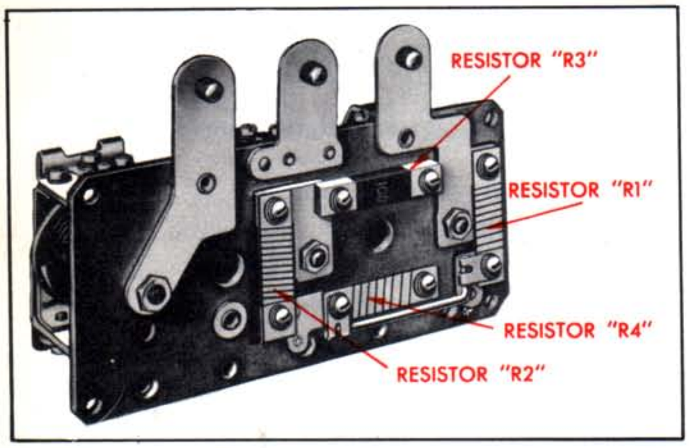


FIGURE 137—RESISTOR ASSEMBLY ON HEAVY DUTY REGULATORS WITH SPECIAL INTERNAL CIRCUITS. This is similar to figure 136 except that four resistors are shown and some of them are the wire wound type rather than the carbon type commonly used.

3. Current Regulator Frequency Winding (Most heavy duty regulators).

Disconnect the leads where they are fastened to the current regulator yoke and to the series connection at the "A" terminal. Measure the resistance between the leads and replace the current regulator unit if the resistance is not within specifications.

Contact Pressure Tests.

(Heavy duty regulators only.)

1. Voltage Regulator.

Connect a battery and a lamp bulb in series with the regulator "A" and "**F**" terminals. See figure 139. Remove the adjusting nut from the armature spring and take off the adjustable point stop. Hold the armature firm and, with a spring scale hooked at the upper contact, pull the contacts apart. See figure 140. Take the reading just as the contacts separate as indicated by the light going out. If the tension is not between 7 and 8 ounces, replace the regulator armature. When re-assembling the armature stop make sure the fibre bumper block is in place.

2. Current Regulator.

Repeat the process as described for the voltage regulator making sure the springs are not interchanged.

Armature Air Gap Tests.

1. Cut-out Relay.

If there is a brass armature stop pin at the center of the core, insert the proper gauge on the contact side and next to the pin. If there is no pin, insert the gauge between the armature and magnet core as near to the hinge end as is possible.

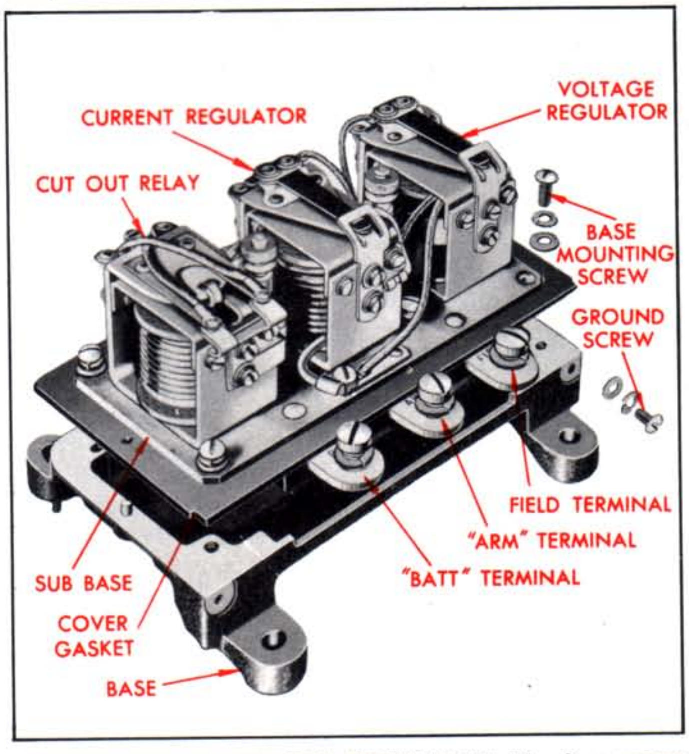


FIGURE 138—HEAVY DUTY REGULATOR. The four screws near the corners mount the sub-base to the base while the screws near the center are used for connecting the various leads to the terminals on the bottom.

Adjust the gap by bending the armature stop making sure the stop does not interfere with the armature movement. See figures 141 and 142. On regulators having a second set of contacts on the cut-out relay, used to operate a tell-tale light, the air gap is adjusted by bending the stationary auxiliary contact bracket as shown in figure 143, keeping the contacts aligned.

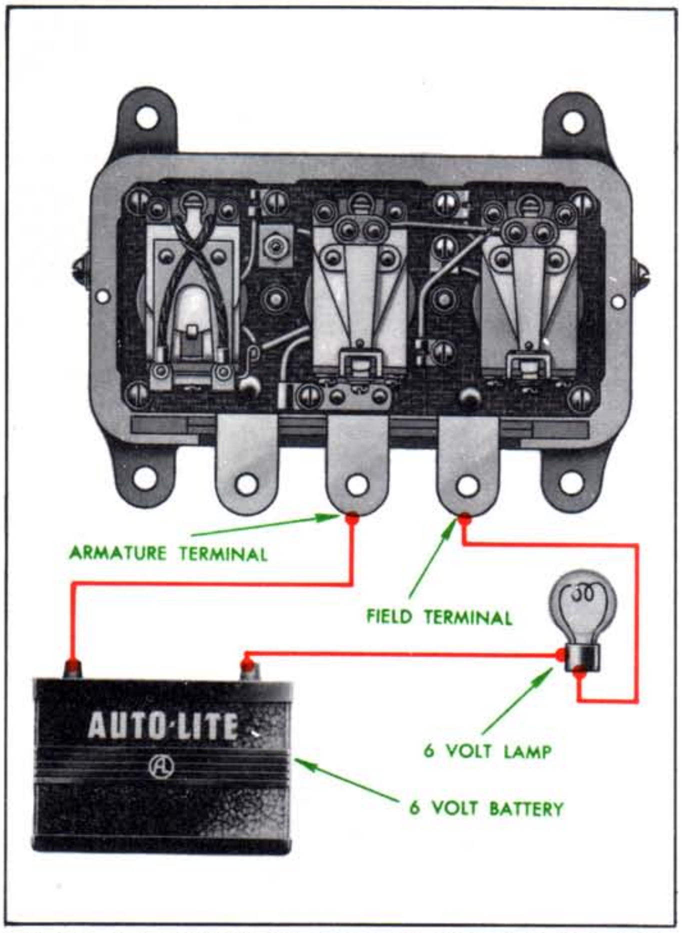


FIGURE 139—INDICATOR HOOKUP FOR TESTING CONTACT PRESSURE AND AIR GAP ON HEAVY DUTY REGULATORS. With the lamp and battery connected in series with the voltage and current regulator contacts, the light indicates whether the contacts are open or closed.

2. Voltage Regulator.

Use pin gauge inserted on the contact side and next to the brass stop pin in the core. The contacts should be closed when the high limit gauge is in place and open when the low limit gauge is in place. Apply pressure near the center of the armature when measuring the air gap, but be careful that the contact spring is not touched. See figures 144 and 145. Adjust the gap by raising or lowering the stationary contact making sure the contacts are kept perfectly aligned.

To indicate when the contacts are closed or open connect a test light in series with the "F" terminal, the regulator base and a battery ("F" terminal, "A" terminal and a battery on heavy duty regulators). See figures 139 and 146. The light will burn brightly when the contacts are closed and will go out or dim when the contacts are open.

3. Current Regulator.

Measure as described for the voltage regulator using the correct gauge specified.

Gap Between Contact Spring and Armature Stop Tests.

(Heavy Duty Units Only.)

1. Voltage Regulator.

Hold the armature against the core stop pin and with a feeler gauge measure the gap between the upper contact spring and the armature stop. If the gap is outside the limits inspect the bumper block for damage or for improper assembly. Inspect the armature stop for distortion or incorrect adjustment.

2. Current Regulator.

Check as described for voltage regulator above.

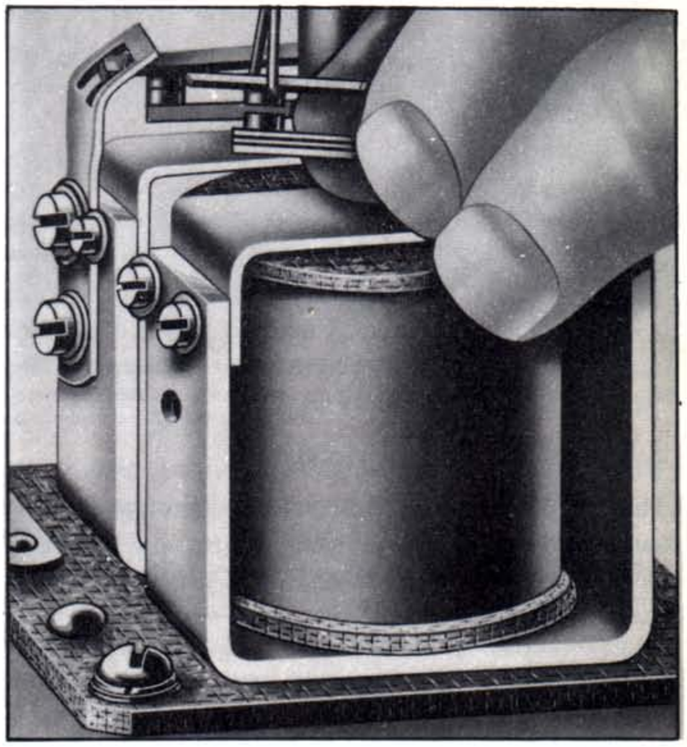


FIGURE 140—MEASURING CONTACT PRESSURE ON HEAVY DUTY REGULATORS. Hook the spring scale under the upper contact arm at the contact and pull the contacts apart with the scale. Hold the armature firmly so that the hinge will not become damaged.

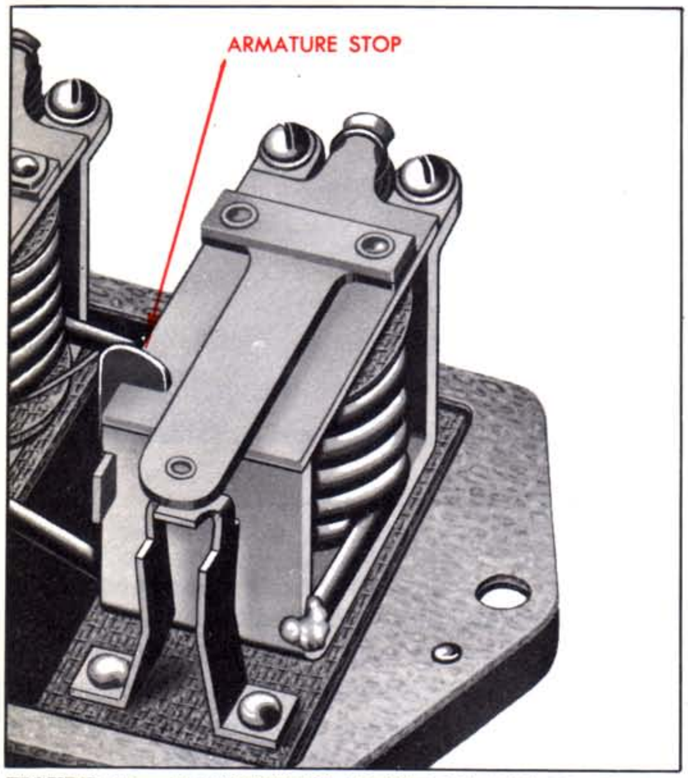


FIGURE 141—ADJUSTMENT OF CUT-OUT RELAY AIR GAP ON MOST REGULATORS. To adjust the gap bend the armature stop so the space between the core and armature is within the limits specified. Be sure stop does not interfere with armature movement.

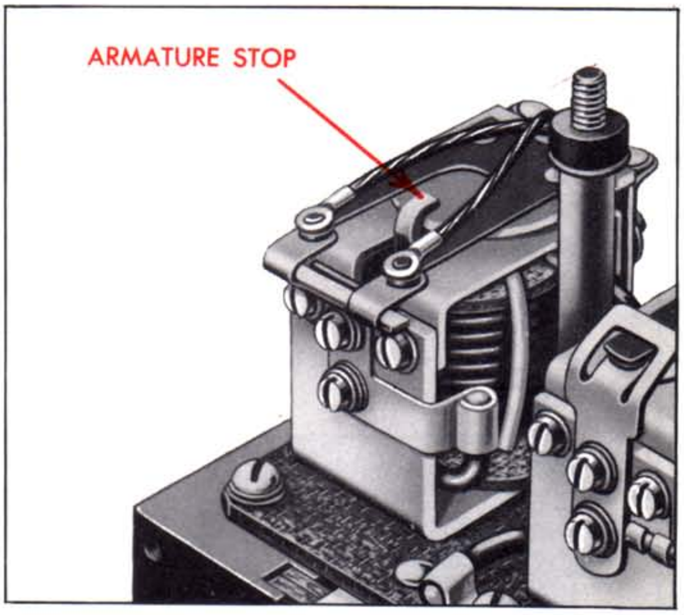


FIGURE 142—ADJUSTMENT OF CUT-OUT RELAY AIR GAP ON HEAVY DUTY REGULATORS. To adjust the gap bend the armature stop so that the space between the core and armature is within the limits specified. Have gauge on contact side and next to the brass armature stop pin in the center of the core.

Contact Point Gap Tests.

1. Cut-out Relay.

With spring tension on the armature and with the armature against the stop measure the gap between the contacts with a flat feeler gauge. This gap should not be less than the minimum specified, but may be larger after completing the adjustment of the cut-out relay opening voltage or current. Be sure both sets of contacts on heavy duty units are aligned for simultaneous closing and opening. See figure 147.

2. Voltage and Current Regulator.

The specifications for this measurement are approximate only. Too much variation in the contact gap indicates wrong length armature stop pin and the unit should be replaced.

Reassembly.

When all preceding checks and adjustments have been completed, all leads which have been disconnected either by the removal of a screw or by unsoldering should be reconnected. Where resoldering is necessary care must be taken that a good clean contact is made.

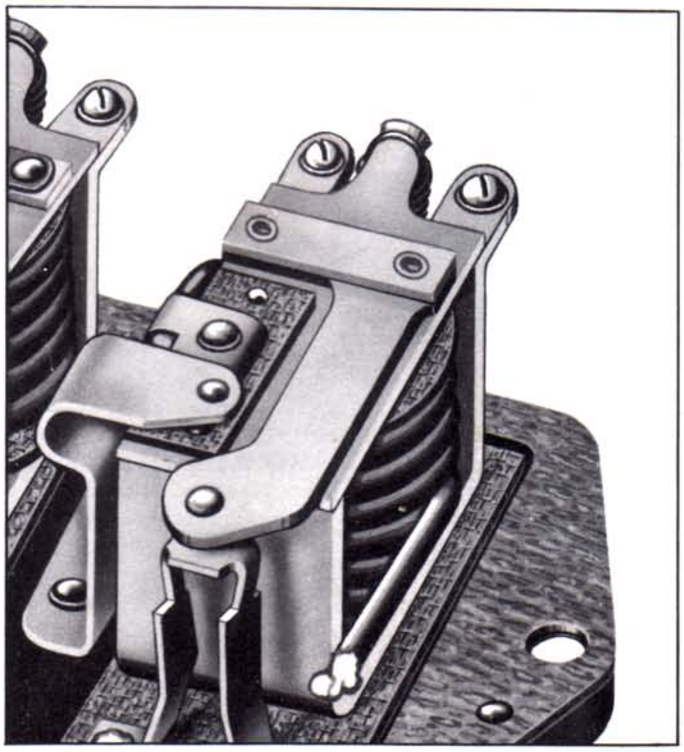


FIGURE 143—ADJUSTMENT OF CUT-OUT RELAY AIR GAP ON REGULATORS HAVING AN AUXILIARY SET OF CONTACTS. These regulators have a set of contacts that operate an indicating light when the generator is not charging. Adjustment of the armature air gap is similar to the regulators illustrated in figure 141 except that the stationary auxiliary contact bracket acts as the stop and must be bent to change the gap. Be sure to keep the contacts aligned.

Do not use acid or paste for soldering flux. Use a rosin and alcohol solution.

After the regulator is completely reassembled, its base should be struck sharply on the bench several times to be sure all parts are settled in place. Be sure to strike the base equally so as not to damage the mounting lugs.

POLARIZING

After the regulator is connected to the generator and battery and before any runs are made, the generator should be polarized with the battery. On small type regulators where the regulation is between field and ground (units similar to figures 110 and 114) connect all of the leads to the regulator and generator then make a momentary connection with a jumper lead from the regulator "A" to "B" terminals. This will not polarize the heavy duty type units (units similar to figure 115) where the regulation is between armature and field. On this type, make all connections at the battery, regulator and generator except the field lead at the regulator. Momentarily touch the field lead to the regulator "battery" terminal then connect the field lead to the "field" terminal.

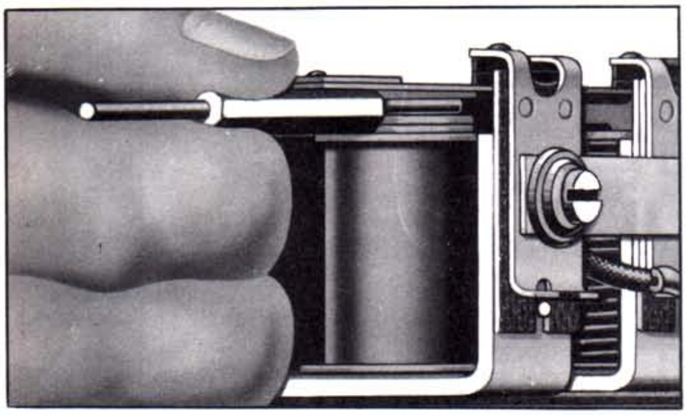


FIGURE 144—MEASURING VOLTAGE AND CURRENT REGULATOR ARMATURE AIR GAP. Place the gauge on the contact side and next to the brass armature stop pin and hold armature down with the fingers being careful not to touch the contact strip. Adjust by raising or lowering the stationary contact bracket.

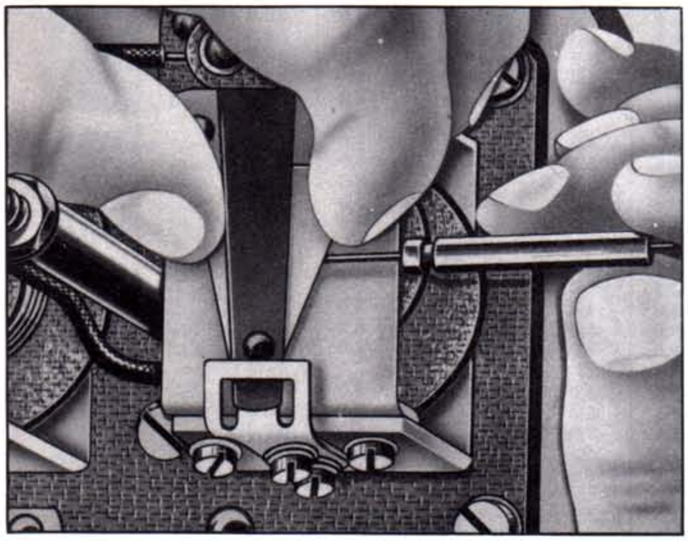


FIGURE 145—MEASURING THE VOLTAGE AND CURRENT REGULATOR ARMATURE AIR GAP ON HEAVY DUTY REGULATORS. This operation is similar to that in figure 144; however, the method of holding the armature down is shown.

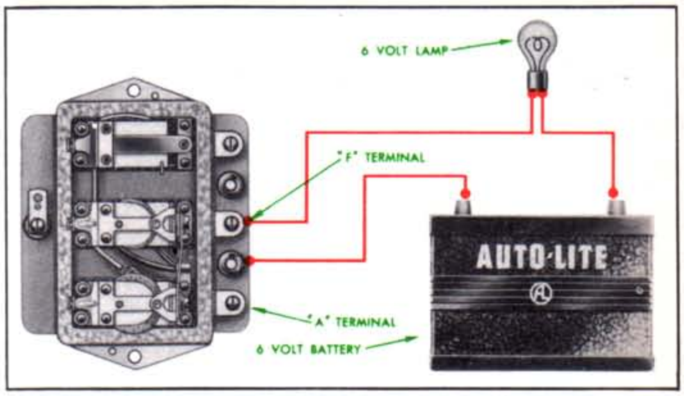


FIGURE 146—TEST HOOKUP FOR INDICATING WHEN THE CONTACTS ARE OPEN AND CLOSED. If a test lamp and battery are connected to the regulator in this manner the lamp will indicate when the contacts are open or closed and facilitate the adjustment of the air gap.

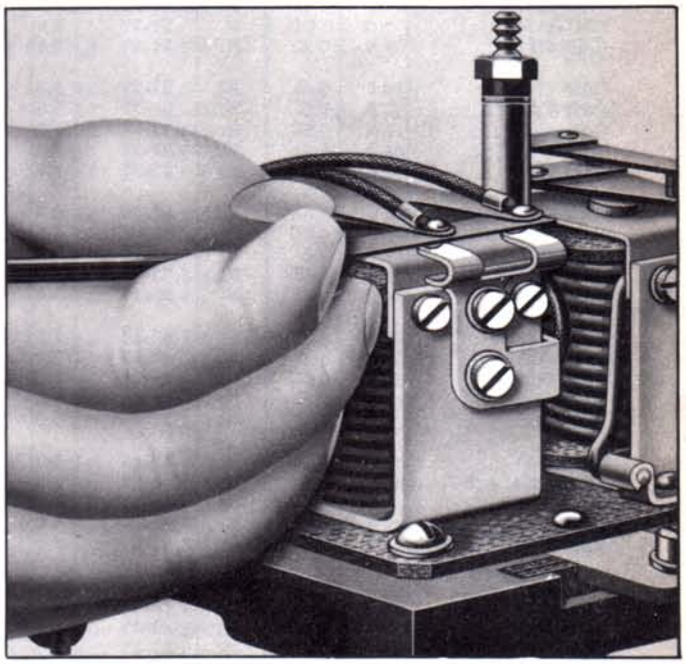


FIGURE 147—ALIGNMENT OF CUT-OUT RELAY CONTACTS ON HEAVY DUTY REGULATORS. Both sets of contacts should have the same gap and both should be adjusted so that they open and close at the same instant.

OPERATING ADJUSTMENTS

See operation test on pages 93 to 96 of this section.

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
CO-1309	6	C	..	20-22	5.0	2.9-3.1	5.0	10.0-12.0	8.0	31.5	.....	TC
DGA-4302	6	C	N	22-27	5.0	2.1-2.3	5.0	6.5-7.3	8.0	30.5	.....	TC
DGA-4601	6	C	N	22-27	5.0	2.1-2.3	5.0	6.5-7.3	8.0	30.5	.....	TC
GAE-4002	12	C	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4007	12	CC	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4020	12	C	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4022	12	C	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4024	12	CC	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	TC
GAE-4026	12	CC	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4027	12	C	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4029	12	C	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4031	12	C	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4040, A	12	C	P	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	TC
GAE-4041	12	C	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	TC
GAE-4042	12	C	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	TC
GAE-4043	12	CC	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	TC
GAE-4044	12	CC	N	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	CO
GAE-4045	12	C	P	20-26	10.0	1.4-1.6	10.0	2.3-2.7	15.0	11.5	.....	TC
GAG-4104	6	CC	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4111	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4115	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4120	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4122	6	CC	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4127	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4133	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4133-3	6	C	N	22-27	5.0	3.4-3.8	5.0	3.2-3.6	8.0	4.3	.....	CO
GAG-4144	6	CC	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4145	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	TC
GAG-4145-2	6	C	N	22-27	5.0	3.4-3.8	5.0	4.0-4.4	8.0	8.8	.....	TC
GAG-4148	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAG-4149	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	TC
GAG-4150	6	C	N	22-27	5.0	3.4-3.8	5.0	3.8-4.2	8.0	16.0	.....	CO
GAL-4309	6	CC	N	17-22	5.0	2.9-3.2	5.0	3.6-4.1	8.0	17.0	.....	CO
GAL-4320	6	C	N	17-22	5.0	2.9-3.2	5.0	3.6-4.1	8.0	17.0	.....	CO
GAL-4336	6	C	N	17-22	5.0	2.9-3.2	5.0	3.6-4.1	8.0	17.0	.....	CO
GAL-4340	6	CC	N	17-22	5.0	2.9-3.2	5.0	3.6-4.1	8.0	17.0	.....	CO
GAM-4504, A,B	6	C	N	18-22	5.0	3.2-3.6	5.0	3.6-4.1	8.0	16.5	.....	CO
GAM-4601	6	C	N	18-22	5.0	3.2-3.6	5.0	3.6-4.1	8.0	16.5	.....	CO
GAP-4101	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4104	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4105	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4107	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4112	6	CC	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4115	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4129	6	CC	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4130	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4133	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4135	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4138	6	CC	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4140	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4142	6	CC	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4146	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4157	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4159	6	C	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAP-4160	6	CC	N	22-27	5.0	2.3-2.6	5.0	5.0-5.6	8.0	16.0	.....	CO
GAR-4302	6	C	N	17-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4316	6	CC	N	17-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4318	6	CC	N	17-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4513	6	C	P	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4515	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4518	6	CC	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4520-7	6	CC	N	18-22	5.0	2.9-3.2	5.0	3.8-4.3	8.0	10.5	.....	CO
GAR-4521	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4522	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4525	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.

CO—Third brush control—uses cut-out relay only.
TC—Third brush and two charge regulator control.

N—Negative ground.
P—Positive ground.

GENERATOR SPECIFICATIONS

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GAR-4526	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4527	6	CC	N	17-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4534	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4535	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4536	6	CC	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4537	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4540	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4541	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4542	6	CC	N	17-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4543	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4545	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4546	6	CC	N	17-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4547	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4548	6	CC	N	17-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	TC
GAR-4549	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4550	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	TC
GAR-4551	6	CC	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	TC
GAR-4554	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAR-4555	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	TC
GAR-4608-5, A-5, B-5,C-5,D-5,E-5	6	C	P	50-60	5.0	2.9-3.2	5.0	4.5-5.1	8.0	21.4	.....	TC
GAR-4609A-4	6	C	P	50-60	5.0	2.9-3.2	5.0	4.0-4.5	8.0	23.4	.....	TC
GAR-4609B-5	6	C	P	50-60	5.0	2.9-3.2	5.0	4.5-5.1	8.0	21.4	.....	TC
GAR-4611-5, A-5	6	C	N	50-60	5.0	2.9-3.2	5.0	4.5-5.1	8.0	21.4	.....	TC
GAR-4612-3	6	C	N	50-60	5.0	2.9-3.2	5.0	4.4-4.8	8.0	20.0	.....	TC
GAR-4613-3	6	C	N	50-60	5.0	2.9-3.2	5.0	4.4-4.8	8.0	20.0	.....	TC
GAR-4613-4	6	C	N	50-60	5.0	2.9-3.2	5.0	4.0-4.5	8.0	23.4	.....	TC
GAR-4614-4	6	C	N	50-60	5.0	2.9-3.2	5.0	4.0-4.5	8.0	23.4	.....	TC
GAR-4614-5	6	C	N	50-60	5.0	2.9-3.2	5.0	4.5-5.1	8.0	21.4	.....	TC
GAR-4616-3	6	C	P	50-60	5.0	2.9-3.2	5.0	4.4-4.8	8.0	20.0	.....	TC
GAR-4618-2	6	C	N	50-60	5.0	2.9-3.2	5.0	4.8-5.3	8.0	18.0	.....	CO
GAR-4619-3	6	C	P	50-60	5.0	2.9-3.2	5.0	4.4-4.8	8.0	20.0	.....	TC
GAR-4621-3	6	CC	N	50-60	5.0	2.9-3.2	5.0	4.4-4.8	8.0	20.0	.....	TC
GAR-4622-3	6	C	N	50-60	5.0	2.9-3.2	5.0	4.4-4.8	8.0	20.0	.....	CO
GAR-4623-4	6	C	N	50-60	5.0	2.9-3.2	5.0	4.0-4.5	8.0	23.4	.....	TC
GAR-4632-3	6	C	N	50-60	5.0	2.9-3.2	5.0	4.4-4.8	8.0	20.0	.....	CO
GAR-4633-3	6	C	N	50-60	5.0	2.9-3.2	5.0	4.4-4.8	8.0	20.0	.....	CO
GAR-4634-2	6	C	N	50-60	5.0	2.9-3.2	5.0	4.8-5.3	8.0	18.0	.....	CO
GAR-4701-6	6	C	P	18-22	5.0	2.9-3.2	5.0	4.8-5.4	8.0	21.5	.....	TC
GAR-4702	6	C	N	18-22	5.0	2.9-3.2	5.0	4.3-4.9	8.0	16.0	.....	CO
GAS-4102	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4102-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4103-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4103-1 M	6	C	P	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4104	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4104-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4104B	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4106	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4108	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4110	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4111, A	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4113	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4114	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4115-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4119	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4120	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4120-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4123	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4124-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4125	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4125-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4126	6	CC	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4127	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4128	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4129	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4131-1, A-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.

CO—Third brush control—uses cut-out relay only.
TC—Third brush and two charge regulator control.

N—Negative ground.
P—Positive ground.

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GAS-4132	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4136-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	TC
GAS-4138	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4139A	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4140	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4141	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4142-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	TC
GAS-4143, A	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4144	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4145	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4148-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	TC
GAS-4149-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	TC
GAS-4150-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4150-1P	6	CC	P	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4151-1, A-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4152	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4153	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4154	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4155	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4157	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4159-1	6	C	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	TC
GAS-4160A	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4161, A	6	C	..	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4162A	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4163	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4164	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4165, B	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4166-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4167	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4168	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4169A	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4170-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	TC
GAS-4172-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4173A	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4175	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4176	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4177, A	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4178	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4179	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4180	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4181A	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4182	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4184-1	6	CC	N	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4185	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4186	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4187	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4188A	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4190	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4191	6	CC	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4192	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	CO
GAS-4193	6	C	N	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4194	6	C	P	15-20	5.0	3.4-3.8	5.0	3.5-4.0	8.0	7.1	.....	CO
GAS-4301	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GAS-4302	6	C	P	15-20	5.0	3.4-3.8	5.0	4.6-5.2	8.0	12.5	.....	TC
GBB-4304	12	C	N	22-27	10.0	2.5-2.9	10.0	3.8-4.3	15.0	17.0	.....	TC
GBB-4604	12	CC	N	22-27	10.0	2.5-2.9	10.0	3.8-4.3	15.0	17.0	.....	TC
GBC-4103	6	C	N	22-27	5.0	2.0-2.3	5.0	4.3-4.7	8.0	22.0	.....	TC
GBC-4606	6	CC	P	22-27	5.0	2.0-2.3	5.0	4.3-4.7	8.0	22.0	.....	TC
GBE-4203	12	C	N	50-60	10.0	2.0-2.3	10.0	3.5-3.9	15.0	15.0	.....	CO
GBE-4204	12	CC	N	50-60	10.0	2.0-2.3	10.0	3.5-3.9	15.0	15.0	.....	CO
GBE-4205	12	C	N	50-60	10.0	2.0-2.3	10.0	3.5-3.9	15.0	15.0	.....	CO
GBE-4206	12	CC	P	50-60	10.0	2.0-2.3	10.0	3.5-3.9	15.0	15.0	.....	CO
GBE-4207	12	CC	P	50-60	10.0	2.0-2.3	10.0	3.5-3.9	15.0	15.0	.....	CO
GBE-4208	12	C	P	50-60	10.0	2.0-2.3	10.0	3.5-3.9	15.0	15.0	.....	CO
GBE-4301	12	C	N	17-22	10.0	2.0-2.3	10.0	3.5-3.9	15.0	15.0	.....	CO

C—Clock wise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.

CO—Third brush control—uses cut-out relay only.
TC—Third brush and two charge regulator control.

N—Negative ground.
P—Positive ground.

GENERATOR SPECIFICATIONS

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GBG-4601*	12	C	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4602*	12	C	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4603*	12	C	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4604*	12	C	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4606*	12	C	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4607A, B*	12	C	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4608, A*	12	C	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4610*	12	CC	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4610N*	12	CC	N	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4611, A*	12	C	P	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4612, A*	12	CC	N	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	40.0	1100	CVR
GBG-4613-1*	12	C	N	23-26	10.0	1.0-1.2	10.0	3.6-4.0	15.0	25.0	1050	CVR
GBK-4602-1	6	C	P	18-22	5.0	3.3-3.7	5.0	4.1-4.5	8.0	22.0	......	TC
GBK-4604	6	C	N	18-22	5.0	3.3-3.7	5.0	4.1-4.4	8.0	20.0	......	CO
GBM-4601	6	C	N	50-60	5.0	3.2-3.6	5.0	5.2-5.8	8.0	20.0	......	CO
GBM-4602	6	C	N	50-60	5.0	3.2-3.6	5.0	5.2-5.8	8.0	20.0	......	CO
GBM-4603-1,B-1	6	C	P	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4604-1,A-1,B-1	6	C	P	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4606-1,B-1,C-1	6	C	P	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4607A-1, B-1	6	C	P	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4608A, B, D	6	C	N	50-60	5.0	3.2-3.6	5.0	5.2-5.8	8.0	20.0	......	CO
GBM-4608C-1	6	C	P	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4609A	6	C	P	50-60	5.0	3.2-3.6	5.0	5.2-5.8	8.0	20.0	......	CO
GBM-4610A-5,B-5,C-5	6	C	P	50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4611A-4	6	C	P	50-60	5.0	3.2-3.6	5.0	4.3-4.8	8.0	11.0	......	CO
GBM-4612A	6	C	N	50-60	5.0	3.2-3.6	5.0	5.2-5.8	8.0	20.0	......	CO
GBM-4613A-1	6	C	P	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4614A-1	6	C	P	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4615A	6	C	N	50-60	5.0	3.2-3.6	5.0	5.2-5.8	8.0	20.0	......	CO
GBM-4616A-1	6	C	P	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	TC
GBM-4617-5	6	C	N	50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4619-5	6	CC	N	50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4620A-1	6	C	N	50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4621-5	6	C	N	50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4622-5, A-5	6	C	N	50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBM-4801-5	6	CC	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4802-5, B-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBM-4802A-5	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBM-4804A-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.8-6.9	8.0	15.0	......	CO
GBM-4804B-5,D-5,E-5	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.8-6.9	8.0	15.0	......	CO
GBM-4805-5	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4806A-4	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.3-4.8	8.0	11.0	......	CO
GBM-4807-1, A-1	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	TC
GBM-4808A-6	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.6-6.7	8.0	9.0	......	TC
GBM-4809A-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.8-6.9	8.0	15.0	......	TC
GBM-4809B-5,B-5M	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.8-6.9	8.0	15.0	......	TC
GBM-4810A-1	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4811-5	6	CC	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4812A-5	6	CC	P	Main 37-44 Third 50-40	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4813-5, A-5	6	CC	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC

*—Brushes are set ½ bar advance of neutral.
C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.

CO—Third brush control—uses cut-out relay only.
TC—Third brush and two charge regulator control.
CVR—Shunt Type—uses vibrating type current-voltage regulator.

N—Negative ground.
P—Positive ground.

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GBM-4814A-1	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	TC
GBM-4815A-5	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBM-4816A-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4817A-5, B-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBM-4818A-1, B-1	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.1-5.8	8.0	18.0	......	CO
GBM-4819A-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBM-4820A-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBM-4821A-5	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	CO
GBM-4822A-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.8-6.9	8.0	15.0	......	TC
GBM-4822BN-5	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.8-6.9	8.0	15.0	......	TC
GBM-4823A-5, A-5M	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	5.8-6.9	8.0	15.0	......	CO
GBM-4824,-5	6	C	N	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBM-4901A-5	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.6	5.0	4.8-5.4	8.0	15.0	......	TC
GBR-4501-3	6	C	N	18-22	5.0	3.4-3.8	5.0	4.9-5.4	8.0	17.0	......	CO
GBR-4502-3	6	CC	N	18-22	5.0	3.4-3.8	5.0	4.9-5.4	8.0	17.0	......	CO
GBR-4601-4	6	C	N	50-60	5.0	3.4-3.8	5.0	5.2-5.7	8.0	26.0	......	TC
GBR-4601-5	6	C	N	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBR-4602-4	6	C	N	50-60	5.0	3.4-3.8	5.0	5.2-5.7	8.0	26.0	......	TC
GBR-4602-5	6	C	N	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBR-4604-5	6	C	P	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBR-4605-5	6	C	N	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBR-4607-5	6	C	P	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBR-4608-5	6	C	N	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBR-4609-5	6	C	P	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBR-4611-5	6	C	P	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBR-4612-5	6	C	P	50-60	5.0	3.4-3.8	5.0	5.0-5.5	8.0	22.0	......	TC
GBS-4502-1	12	C	N	18-22	10.0	2.5-2.8	10.0	2.5-2.9	15.0	10.1	......	CO
GBS-4605	12	C	N	50-60	10.0	2.5-2.8	10.0	3.2-3.6	15.0	11.0	......	TC
GBS-4606	12	CC	N	50-60	10.0	2.5-2.8	10.0	3.2-3.6	15.0	11.0	......	TC
GBS-4611-1	12	C	N	50-60	10.0	2.5-2.8	10.0	2.5-2.9	15.0	10.1	......	TC
GBS-4612-1	12	C	P	50-60	10.0	2.5-2.8	10.0	2.5-2.9	15.0	10.1	......	TC
GBU-4202	6	C	P	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	TC
GBU-4203	6	CC	P	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	TC
GBU-4208	6	C	P	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	CO
GBU-4209, A	6	C	P	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	TC
GBU-4210	6	C	N	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	CO
GBU-4211	6	CC	N	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	CO
GBU-4212	6	C	N	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	CO
GBU-4213A	6	C	N	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	TC
GBU-4214	6	C	N	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	TC
GBU-4216, A, B	6	C	P	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	TC
GBU-4217	6	CC	P	50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	CO
GBU-4801	6	C	P	Main 37-44 Third 50-60	5.0	2.8-3.1	5.0	3.7-4.1	8.0	10.7	......	CO
GBW-4602	6	C	P	35-53	5.0	1.4-1.6	5.0	2.8-3.1	8.0	22.0	1900	CVR
GBW-4802	6	C	P	35-53	5.0	1.4-1.6	5.0	2.8-3.1	8.0	22.0	1900	CVR
GBW-4803, A, B, C, D, E	6	C	P	35-53	5.0	1.4-1.6	5.0	2.8-3.1	8.0	22.0	1900	CVR
GBW-4804, A	6	C	P	35-53	5.0	1.4-1.6	5.0	2.8-3.1	8.0	22.0	1900	CVR
GBW-4805, A	6	C	P	35-53	5.0	1.4-1.6	5.0	2.8-3.1	8.0	22.0	1900	CVR
GBW-4808-1	6	C	P	35-53	5.0	1.4-1.6	5.0	2.8-3.1	8.0	14.0	1475	CVR
GBW-4809A	6	C	P	35-53	5.0	1.4-1.6	5.0	2.8-3.1	8.0	22.0	1900	CVR

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.

TC—Third brush and two charge regulator control.
CVR—Shunt Type—uses vibrating type current-voltage regulator.

N—Negative ground.
P—Positive ground.

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GCB-4601	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4802, A, B	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4803A, B	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4804	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4805	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4806	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4807A	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4808	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4809A	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4810, A	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4811, A	6	CC	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4814A	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4815A	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4817A	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCB-4820	6	C	P	64-68	5.0	1.2-1.5	5.0	2.5-2.9	8.0	25.0	1100	CVR
GCD-4801	12	C	P	30-37	10.0	0.8-1.0	10.0	2.5-2.8	15.0	20.0	1200	CVR
GCD-4804	12	C	P	30-37	10.0	0.8-1.0	10.0	2.5-2.8	15.0	20.0	1200	CVR
GCD-4808A	12	C	P	30-37	10.0	0.8-1.0	10.0	2.5-2.8	15.0	20.0	1200	CVR
GCD-4809	12	C	P	30-37	10.0	0.8-1.0	10.0	2.5-2.8	15.0	20.0	1200	CVR
GCE-4803A	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4804A, B	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4806	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4807A, B	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4808	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4810	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4812	6	C	N	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4813	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4814A	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4815A	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4816A	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4817	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4822A	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCE-4824A	6	C	P	64-68	5.0	1.4-1.6	5.0	4.8-5.3	8.0	30.0	1600	CVR
GCG-4601‡	6	CC	..	24-36	5.0	1.9-2.0	5.0	14-16	8.0	30.0	4100	....
GCH-4601*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4602*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4603*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4604, B*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4604AN-1, BN-1, N-1*	6	C	N	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	50.0	1075	CVR
GCH-4605*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4606*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4607A-1*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	50.0	1075	CVR
GCH-4608-1*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	50.0	1075	CVR
GCH-4609A*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4609A-1*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	50.0	1075	CVR
GCH-4610B*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4612A*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	40.0	1025	CVR
GCH-4612B-1*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	50.0	1075	CVR
GCH-4613A-1*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	50.0	1075	CVR
GCH-4614-1*	6	C	P	23-26	5.0	0.9-1.1	5.0	5.8-6.4	8.0	50.0	1075	CVR
GCJ-4801A	6	C	P	35-53	5.0	1.7-1.9	5.0	3.7-4.2	8.0	25.0	......	VR
GCJ-4802, A, B, C	6	C	P	35-53	5.0	1.7-1.9	5.0	3.7-4.2	8.0	25.0	......	VR
GCJ-4803A	6	C	P	35-53	5.0	1.7-1.9	5.0	3.7-4.2	8.0	25.0	......	VR
GCJ-4804A-1	6	C	P	35-53	5.0	1.7-1.9	5.0	3.7-4.1	8.0	18.0	......	CO
GCJ-4805A, B	6	C	N	35-53	5.0	1.7-1.9	5.0	3.7-4.2	8.0	25.0	......	VR
GCJ-4806	6	C	N	35-53	5.0	1.7-1.9	5.0	3.7-4.2	8.0	25.0	......	VR
GCJ-4807A-2	6	C	P	35-53	5.0	1.7-1.9	5.0	3.8-4.2	8.0	30.5	......	VR
GCJ-4808A	6	C	P	35-53	5.0	1.7-1.9	5.0	3.7-4.2	8.0	25.0	......	VR
GCJ-4810A-2	6	C	P	35-53	5.0	1.7-1.9	5.0	3.8-4.2	8.0	30.5	......	VR
GCJ-4811A	6	C	N	35-53	5.0	1.7-1.9	5.0	3.7-4.2	8.0	25.0	......	VR
GCJ-4812-3	6	CC	N	35-53	5.0	1.7-1.9	5.0	3.7-4.1	8.0	18.0	......	CO
GCJ-4813-3	6	CC	N	35-53	5.0	1.7-1.9	5.0	3.7-4.1	8.0	18.0	......	CO
GCJ-4814-3	6	C	N	35-53	5.0	1.7-1.9	5.0	3.7-4.1	8.0	18.0	......	CO
GCJ-4815-3	6	C	N	35-53	5.0	1.7-1.9	5.0	3.7-4.1	8.0	18.0	......	CO
GCJ-4816-3	6	CC	P	35-53	5.0	1.7-1.9	5.0	3.7-4.1	8.0	18.0	......	CO

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
VR—Third brush and vibrating voltage regulator control.
‡—Stall torque at 5.0 volts—165 max. amperes, 3.0 minimum Lbs. Ft.
CVR—Shunt Type—uses vibrating type current-voltage regulator.
***—Brushes are set ½ bar advance of neutral.**
CO—Third brush control—uses cut-out relay only.
N—Negative ground.
P—Positive ground.

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GCK-4801, A, B, C, D, E	12	C	P	35-53	10.0	1.1-1.3	10.0	2.5-2.9	15.0	12.0	1600	CVR
GCK-4803A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.5-2.9	15.0	12.0	1600	CVR
GCK-4804-1	12	CC	P	35-53	10.0	1.1-1.3	10.0	2.5-2.9	15.0	8.0	1375	CVR
GCK-4805, A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.5-2.9	15.0	12.0	1600	CVR
GCK-4806-1	12	C	P	35-53	10.0	1.1-1.3	10.0	2.5-2.9	15.0	8.0	1375	CVR
GCK-4807-1	12	CC	P	35-53	10.0	1.1-1.3	10.0	2.5-2.9	15.0	8.0	1375	CVR
GCK-4808-1	12	C	P	35-53	10.0	1.1-1.3	10.0	2.5-2.9	15.0	8.0	1375	CVR
GCM-4802A-4,B-4	6	C	P	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4803-4,A-4,B-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	CO
GCM-4804-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4805-4	6	CC	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4806-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	CO
GCM-4807A-4	6	C	P	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	CO
GCM-4808-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	CO
GCM-4809A-4	6	C	P	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	CO
GCM-4810-4	6	C	P	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4811-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	CO
GCM-4812	6	C	N	35-53	5.0	2.9-3.2	5.0	4.3-4.8	8.0	16.0	......	CO
GCM-4815A-4	6	C	P	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4816A-4,C-4	6	C	P	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4816B-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4818	6	C	N	Main 35-53 Third 50-60	5.0	2.9-3.2	5.0	4.3-4.8	8.0	16.0	......	CO
GCM-4819-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4820	6	CC	N	Main 35-53 Third 50-60	5.0	2.9-3.2	5.0	4.3-4.8	8.0	16.0	......	CO
GCM-4821	6	C	N	Main 35-53 Third 50-60	5.0	2.9-3.2	5.0	4.3-4.8	8.0	16.0	......	CO
GCM-4822-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4823-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCM-4824-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	CO
GCM-4825A-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	CO
GCM-4827	6	C	N	Main 35-53 Third 50-60	5.0	2.9-3.2	5.0	4.3-4.8	8.0	16.0	......	TC
GCM-4830-4	6	C	N	35-53	5.0	2.9-3.2	5.0	5.0-5.5	8.0	22.0	......	TC
GCO-4801,A,B,C,D	6	C	P	35-53	5.0	1.2-1.4	5.0	3.7-4.1	8.0	28.0	1950	CVR
GCO-4802, A, B, C	6	C	P	35-53	5.0	1.2-1.4	5.0	3.7-4.1	8.0	28.0	1950	CVR
GCO-4803A	6	C	P	35-53	5.0	1.2-1.4	5.0	3.7-4.1	8.0	28.0	1950	CVR
GCO-4804A	6	C	P	35-53	5.0	1.2-1.4	5.0	3.7-4.1	8.0	28.0	1950	CVR
GCO-4806A	6	C	P	35-53	5.0	1.2-1.4	5.0	3.7-4.1	8.0	28.0	1950	CVR
GCO-4807A	6	C	P	35-53	5.0	1.2-1.4	5.0	3.7-4.1	8.0	28.0	1950	CVR
GCO-4808A	6	C	P	35-53	5.0	1.2-1.4	5.0	3.7-4.1	8.0	28.0	1950	CVR
GCP-4801	6	C	P	35-53	5.0	1.5-1.8	5.0	2.7-3.2	8.0	12.0	1375	CVR
GCP-4802	6	CC	P	35-53	5.0	1.5-1.8	5.0	2.7-3.2	8.0	12.0	1375	CVR
GCR-4801, A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.3-2.6	15.0	15.0	1650	CVR
GCR-4802	12	C	P	35-53	10.0	1.1-1.3	10.0	2.3-2.6	15.0	15.0	1650	CVR
GCR-4802N	12	C	N	35-53	10.0	1.1-1.3	10.0	2.3-2.6	15.0	15.0	1650	CVR
GCR-4803A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.3-2.6	15.0	15.0	1650	CVR
GCS-4801-5	6	C	P	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4802-5	6	C	P	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4803A-5, B-5, C-5, D-5	6	C	P	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4804A-5, B-5, C-5	6	C	N	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4804D-5,DA-5	6	C	P	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4805A-5	6	C	N	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4806A-5	6	C	P	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4807-1	6	CC	N	35-53	5.0	3.0-3.4	5.0	4.4-5.0	8.0	14.0	......	CO
GCS-4808-5	6	C	N	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4809A-5	6	C	N	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4811A-5, B-5	6	C	P	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4812-5	6	C	P	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4813A-5	6	C	P	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4814-5	6	C	N	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4815-5	6	C	N	35-53	5.0	3.0-3.4	5.0	4.6-5.1	8.0	20.0	......	TC
GCS-4816-1	6	CC	P	35-53	5.0	3.0-3.4	5.0	4.4-5.0	8.0	14.0	......	CO

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.
TC—Third brush and two charge regulator control.
CVR—Shunt Type—uses vibrating type current-voltage regulator.
N—Negative ground.
P—Positive ground.

GENERATOR SPECIFICATIONS

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GCT-4801A-1	12	C	P	35-53	10.0	1.1-1.3	10.0	2.0-2.3	15.0	8.5	......	CO
GCT-4802A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.2-2.5	15.0	12.5	......	VR
GCT-4803-1	12	C	P	35-53	10.0	1.1-1.3	10.0	2.0-2.3	15.0	8.5	......	VR
GCT-4804A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.2-2.5	15.0	12.5	......	VR
GCT-4808A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.2-2.5	15.0	12.5	......	VR
GCT-4812A-1, B-1	12	C	P	35-53	10.0	1.1-1.3	10.0	2.0-2.3	15.0	8.5	......	VR
GCT-4813	12	C	P	35-53	10.0	1.1-1.3	10.0	2.2-2.5	15.0	12.5	......	VR
GCU-4801-5	12	C	P	35-53	10.0	2.0-2.3	10.0	4.0-4.5	15.0	13.0	......	TC
GCW-4802, A	12	CC	P	64-68	10.0	0.9-1.1	10.0	3.0-3.3	15.0	17.0	1275	CVR
GCW-4804A	12	CC	P	64-68	10.0	0.9-1.1	10.0	3.0-3.3	15.0	17.0	1275	CVR
GCW-4805, A, B	12	C	P	64-68	10.0	0.9-1.1	10.0	3.0-3.3	15.0	17.0	1275	CVR
GCW-4806	12	CC	P	64-68	10.0	0.9-1.1	10.0	3.0-3.3	15.0	17.0	1275	CVR
GCX-4501	6	C	P	7-10	5.0	3.4-3.9	5.0	3.3-3.7	8.0	19.0	......	TC
GCX-4502	6	C	P	7-10	5.0	3.4-3.9	5.0	3.3-3.7	8.0	19.0	......	CO
GCX-4503	6	C	P	7-10	5.0	3.4-3.9	5.0	3.3-3.7	8.0	19.0	......	CO
GCY-4601, A*	12	C	P	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	33.0	1150	CVR
GCY-4603-1*	12	CC	N	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	20.0	1000	CVR
GCY-4604-1*	12	CC	N	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	20.0	1000	CVR
GCY-4606A-2*	12	C	P	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	40.0	1300	CVR
GCY-4607-1*	12	C	N	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	20.0	1000	CVR
GCY-4608-1*	12	C	N	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	20.0	1000	CVR
GCY-4609-1*	12	CC	N	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	20.0	1000	CVR
GCY-4610A-1*	12	C	N	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	20.0	1000	CVR
GCY-4611-1*	12	C	N	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	20.0	1000	CVR
GCY-4612-1*	12	C	N	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	20.0	1000	CVR
GCY-4613A*	12	C	P	23-26	10.0	0.9-1.0	10.0	3.9-4.4	15.0	33.0	1150	CVR
GCZ-4803	6	CC	P	35-53	5.0	1.6-1.8	5.0	3.9-4.3	8.0	21.0	......	CO
GCZ-4805	6	CC	P	35-53	5.0	1.6-1.8	5.0	3.9-4.3	8.0	21.0	......	CO
GDA-4801, A, B, C, D, E	6	C	P	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	28.0	2125	CVR
GDA-4802	6	C	P	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	28.0	2125	CVR
GDA-4803, A	6	C	P	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	28.0	2125	CVR
GDA-4804A	6	C	P	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	28.0	2125	CVR
GDA-4805	6	C	P	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	28.0	2125	CVR
GDA-4806	6	C	P	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	28.0	2125	CVR
GDA-4808A	6	C	P	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	28.0	2125	CVR
GDA-4809A-1, B-1, C-1	6	C	P	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	25.0	1975	CVR
GDA-4810A-1	6	C	N	35-53	5.0	1.4-1.6	5.0	3.3-3.8	8.0	25.0	1975	CVR
GDB-4802-2	12	CC	P	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.4-3.8	15.0	10.0	......	CO
GDB-4803-2	12	C	P	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.4-3.8	15.0	10.0	......	CO
GDB-4804A, B, D	12	C	N	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.2-3.7	15.0	11.0	......	TC
GDB-4804C	12	C	P	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.2-3.7	15.0	11.0	......	TC
GDB-4805	12	CC	N	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.2-3.7	15.0	11.0	......	TC
GDB-4810A, B	12	CC	N	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.2-3.7	15.0	11.0	......	TC
GDB-4812A	12	CC	N	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.2-3.7	15.0	11.0	......	TC
GDB-4813-2	12	CC	P	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.4-3.8	15.0	10.0	......	TC
GDB-4814	12	C	N	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.2-3.7	15.0	11.0	......	TC
GDB-4814P	12	C	P	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.2-3.7	15.0	11.0	......	TC
GDB-4816A-2	12	C	P	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.4-3.8	15.0	10.0	......	TC
GDB-4817-2	12	C	P	Main 35-53 Third 50-60	10.0	2.5-2.9	10.0	3.4-3.8	15.0	10.0	......	TC
GDC-4601A†	12	CC	..	50-60	10.0	1.0-1.2	10.0	6.0-7.0	15.0	16.0	4300	....

***—Brushes are set ⅓ bar advance of neutral.**
C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.

†—Stall torque at 10.0 volts—110 max. amperes, 4.0 minimum Lbs. Ft.
CVR—Shunt Type—uses vibrating type current-voltage regulator.
VR—Third brush and vibrating voltage regulator control.
TC—Third brush and two charge regulator control.

N—Negative ground.
P—Positive ground.

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GDD-4801	12	CC	P	64-68	10.0	1.1-1.3	10.0	4.9-5.5	15.0	17.0	1925	CVR
GDD-4802	12	C	P	64-68	10.0	1.1-1.3	10.0	4.9-5.5	15.0	17.0	1925	CVR
GDE-4101, A	6	C	N	15-20	5.0	3.1-3.5	5.0	4.5-5.1	8.0	18.0	......	TC
GDE-4102	6	CC	N	15-20	5.0	3.1-3.5	5.0	4.5-5.1	8.0	18.0	......	TC
GDE-4103	6	CC	N	15-20	5.0	3.1-3.5	5.0	4.5-5.1	8.0	18.0	......	TC
GDE-4104	6	CC	N	15-20	5.0	3.1-3.5	5.0	4.5-5.1	8.0	18.0	......	TC
GDE-4105	6	CC	N	15-20	5.0	3.1-3.5	5.0	4.5-5.1	8.0	18.0	......	TC
GDE-4106	6	CC	N	15-20	5.0	3.1-3.5	5.0	4.5-5.1	8.0	18.0	......	TC
GDE-4107	6	CC	N	15-20	5.0	3.1-3.5	5.0	4.5-5.1	8.0	18.0	......	TC
GDE-4108	6	CC	N	15-20	5.0	3.1-3.5	5.0	4.5-5.1	8.0	18.0	......	TC
GDF-4801, A,B,C,D	6	C	P	35-53	5.0	1.5-1.7	5.0	5.0-5.7	8.0	30.5	......	VR
GDF-4802A	6	C	P	35-53	5.0	1.5-1.7	5.0	5.0-5.7	8.0	30.5	......	VR
GDF-4803A-1	6	C	P	35-53	5.0	1.5-1.7	5.0	4.3-5.0	8.0	18.0	......	CO
GDF-4804A,B	6	C	P	35-53	5.0	1.5-1.7	5.0	5.0-5.7	8.0	30.5	......	VR
GDF-4805-2	6	CC	P	35-53	5.0	1.5-1.7	5.0	3.8-4.2	8.0	20.0	......	CO
GDF-4806-2	6	C	P	35-53	5.0	1.5-1.7	5.0	3.8-4.2	8.0	20.0	......	CO
GDF-4807-2	6	C	P	35-53	5.0	1.5-1.7	5.0	3.8-4.2	8.0	20.0	......	CO
GDF-4808-2	6	CC	P	35-53	5.0	1.5-1.7	5.0	3.8-4.2	8.0	20.0	......	CO
GDF-4811A-2	6	CC	P	35-53	5.0	1.5-1.7	5.0	3.8-4.2	8.0	20.0	......	CO
GDF-4812A	6	C	P	35-53	5.0	1.5-1.7	5.0	5.0-5.7	8.0	30.5	......	VR
GDF-4813-2	6	C	P	35-53	5.0	1.5-1.7	5.0	3.8-4.2	8.0	20.0	......	CO
GDF-4814-2	6	CC	P	35-53	5.0	1.5-1.7	5.0	3.8-4.2	8.0	20.0	......	CO
GDF-4815A	6	CC	P	35-53	5.0	1.5-1.7	5.0	5.0-5.7	8.0	30.5	......	VR
GDG-4501	6	C	P	7-10	5.0	3.4-3.9	5.0	3.5-3.9	8.0	20.0	1100	....
GDH-4801	6	C	P	35-53	5.0	2.9-3.2	5.0	3.8-3.9	8.0	6.3	......	TC
GDJ-4802A	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4803A	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4804, A, B, C	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4804AA	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4805A	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4806, A	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4808, A, AA, B	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4809A, B	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4809AP	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4811A	12	CC	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4812A	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4813A-1, B-1, C-1	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	50.0	1100	CVR
GDJ-4815	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4816	12	CC	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4819A	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4820A	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4822A, C	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4824A	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4825A	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4828	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4829A, B	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4831AU	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4832AM	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4833	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4834AU	12	C	N	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4836	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	40.0	1075	CVR
GDJ-4837A, B	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDJ-4838A, B	12	C	P	71-76	10.0	1.1-1.3	10.0	6.9-7.7	15.0	55.0	1125	CVR
GDK-4601	12	C	P	35-41	10.0	1.3-1.5	10.0	2.5-2.9	15.0	15.0	......	TC
GDK-4602	12	CC	P	35-41	10.0	1.3-1.5	10.0	2.5-2.9	15.0	15.0	......	TC
GDK-4801-1	12	C	..	35-41	10.0	1.3-1.5	10.0	2.4-2.6	15.0	13.0	......	CO
GDK-4802-1	12	CC	N	35-41	10.0	1.3-1.5	10.0	2.4-2.6	15.0	13.0	......	CO
GDK-4803-1	12	CC	N	35-41	10.0	1.3-1.5	10.0	2.4-2.6	15.0	13.0	......	TC
GDK-4804-1	12	C	N	35-41	10.0	1.3-1.5	10.0	2.4-2.6	15.0	13.0	......	TC
GDK-4901-1	12	C	N	35-41	10.0	1.3-1.5	10.0	2.4-2.6	15.0	13.0	......	CO
GDL-4801	6	CC	N	64-68	5.0	1.2-1.5	5.0	5.2-5.8	8.0	20.0	1325	CVR
GDM-4801	12	CC	N	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	15.0	1300	CVR
GDM-4803-1	12	C	P	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	30.0	1525	CVR
GDM-4803-1N	12	C	N	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	30.0	1525	CVR
GDM-4804A-1, B-1	12	C	N	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	30.0	1525	CVR

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.

TC—Third brush and two charge regulator control.
VR—Third brush and vibrating voltage regulator control.
CVR—Shunt Type—uses vibrating type current-voltage regulator.

N—Negative ground.
P—Positive ground.

GENERATOR SPECIFICATIONS

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GDM-4806-1	12	CC	P	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	30.0	1525	CVR
GDM-4807A-1, B-1	12	CC	P	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	30.0	1525	CVR
GDM-4808-1	12	CC	P	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.00	30.0	1525	CVR
GDM-4810-1	12	C	P	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	30.0	1525	CVR
GDM-4811	12	CC	N	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	15.0	1300	CVR
GDM-4812	12	C	N	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	15.0	1300	CVR
GDM-5001-2	12	C	N	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	35.0	1700	CVR
GDO-4601A-1	6	C	P	23-26	5.0	0.9-1.1	5.0	4.6-5.1	8.0	30.0	900	CVR
GDP-4801, A, B, C	12	C	P	35-53	10.0	1.1-1.3	10.0	2.3-2.6	15.0	15.0	1750	CVR
GDP-4802A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.3-2.6	15.0	15.0	1750	CVR
GDP-4803A, B	12	C	P	35-53	10.0	1.1-1.3	10.0	2.3-2.6	15.0	15.0	1750	CVR
GDP-4804A	12	C	P	35-53	10.0	1.1-1.3	10.0	2.3-2.6	15.0	15.0	1750	CVR
GDS-4801A	6	C	P	35-53	5.0	1.3-1.5	5.0	4.9-5.2	8.0	33.0	......	VR
GDS-4802A, B	6	C	P	35-53	5.0	1.3-1.5	5.0	4.9-5.2	8.0	33.0	......	VR
GDS-4803A-1	6	C	P	35-53	5.0	1.3-1.5	5.0	4.6-4.8	8.0	20.0	......	CO
GDT-4802	6	C	P	30-37	5.0	1.2-1.5	5.0	4.0-4.5	8.0	40.0	1450	CVR
GDT-4803A	6	C	N	30-37	5.0	1.2-1.5	5.0	4.0-4.5	8.0	40.0	1450	CVR
GDT-4804A	6	C	P	30-37	5.0	1.2-1.5	5.0	4.0-4.5	8.0	40.0	1450	CVR
GDU-4501	6	C	P	7-10	5.0	3.0-3.4	5.0	2.7-3.0	8.0	18.0	......	CO
GDW-4601, A*	24	C	P	23-26	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	975	CVR
GDW-4602*	24	CC	P	23-26	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	975	CVR
GDW-4604A, B*	24	C	P	23-26	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	975	CVR
GDW-4605-1*	32	CC	N	23-26	25.0	0.9-1.0	25.0	2.1-2.3	40.0	7.0	1050	CVR
GDW-4606*	24	C	P	23-26	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	975	CVR
GDW-4607A*	24	C	P	23-26	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	975	CVR
GDW-4608*	24	CC	P	23-26	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	975	CVR
GDW-4608A*	32	CC	P	23-26	25.0	0.9-1.0	25.0	2.1-2.3	40.0	7.0	1050	CVR
GDW-4609A*	24	C	P	23-26	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	975	CVR
GDW-4610M-2*	32	C	P	23-26	25.0	0.9-1.0	25.0	2.1-2.3	40.0	7.0	1050	CVR
GDY-4104, A	12	CC	N	15-20	10.0	1.7-2.0	10.0	2.4-2.7	15.0	6.5	......	TC
GDY-4106	12	C	P	15-20	10.0	1.7-2.0	10.0	2.4-2.7	15.0	6.5	......	TC
GDY-4107A	12	C	N	15-20	10.0	1.7-2.0	10.0	2.4-2.7	15.0	6.5	......	TC
GDY-4112	12	C	P	15-20	10.0	1.7-2.0	10.0	2.4-2.7	15.0	6.5	......	TC
GDZ-4801, A, B, C, D, E, F, G, H, K, Q, R, T, V	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4801J-1	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	22.0	1700	CVR
GDZ-4801L	6	C	N	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4802A, B	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4803A, B	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4804A	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4805A	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4805B	6	C	N	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4806A, B	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4807, A	5	CC	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4808	6	CC	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4809	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4810A	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4811A	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4811BN	6	C	N	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4812A, B	6	CC	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4813, A, B, C, D, E, F, G	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4814AM, M	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4816AM, M	6	CC	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4817A, B	6	C	N	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4818A, B	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4819AM, AM-2, BM, M	6	CC	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	17.0	1500	CVR
GDZ-4820AM, AM-2, BM, M	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	17.0	1500	CVR
GDZ-4821A	6	C	N	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-4822A, A-1	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	17.0	1500	CVR
GDZ-4823AM	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	17.0	1500	CVR
GDZ-6001A, B	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR

***—Brushes are set ½ bar advance of neutral.**
C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.

TC—Third brush and two charge regulator control.
VR—Third brush and vibrating voltage regulator control.
CVR—Shunt Type—uses vibrating type current-voltage regulator.

N—Negative ground.
P—Positive ground.

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GDZ-6001C	6	C	N	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GDZ-6002A	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.4	8.0	35.0	2000	CVR
GEA-4801, A, B	6	C	P	35-53	5.0	1.3-1.5	5.0	4.1-4.5	8.0	35.0	1600	CVR
GEA-4802A-1	6	C	P	35-53	5.0	1.3-1.5	5.0	4.1-4.5	8.0	35.0	1750	CVR
GEA-4803A, B	6	C	P	35-53	5.0	1.3-1.5	5.0	4.1-4.5	8.0	35.0	1600	CVR
GEA-4804A	6	C	P	35-53	5.0	1.3-1.5	5.0	4.1-4.5	8.0	35.0	1600	CVR
GEB-4801, A, B	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4801N	6	C	N	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4802, A, B	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4802B-2, C-2	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	35.0	1300	CVR
GEB-4803A, B	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4804A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4805A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4806, A, B, C, D, E, F, G, H	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4807	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4809	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4810	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4812	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4813	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4814	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4816A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4819	6	CC	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4819-3, M-3	6	CC	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	25.0	1200	CVR
GEB-4820-1	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	16.0	975	CVR
GEB-4821A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4822, A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4823	6	CC	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4824-1	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	16.0	975	CVR
GEB-4825A, B	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4825AN, BN	6	C	N	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4826-3, A-3	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	25.0	1200	CVR
GEB-4827, A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4828A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4832, M	6	CC	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4833, M	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-4834A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEB-6001, A, B, C, D, DM, E, F, G, H, S, S-1	6	C	P	64-68	5.0	1.3-1.5	5.0	3.7-4.3	8.0	32.0	1275	CVR
GEC-4801A	6	C	P	35-53	5.0	1.3-1.5	5.0	4.6-5.2	8.0	40.5	......	VR
GED-4501	12	C	P	7-10	10.0	1.5-1.7	10.0	1.4-1.6	15.0	9.0	......	CO
GEE-4501	6	C	N	7-10	5.0	1.8-2.1	5.0	1.8-2.2	8.0	14.0	......	CO
GEE-4502	6	C	N	7-10	5.0	1.8-2.1	5.0	1.8-2.2	8.0	14.0	......	CO
GEF-4801, A, AA, B, C, E	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4801AN	12	C	N	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4801D	12	C	N	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4803	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4805A	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4806, A, B	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4809AM, BM, M	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4810AM, BM, M	12	CC	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4811AM	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	18.0	1750	CVR
GEF-4813A, A-2, B, C	12	C	P	35-53	10.0	1.0-1.2	10.0	3.6-4.5	15.0	12.0	1550	CVR
GEF-4814AM, BM, M	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	12.0	1550	CVR
GEF-4815AM, BM, M	12	CC	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	12.0	1550	CVR
GEF-4816	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	12.0	1550	CVR
GEF-4817	12	CC	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	12.0	1550	CVR
GEF-4818AM	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	12.0	1550	CVR
GEF-4901M	12	C	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	12.0	1550	CVR
GEF-4902M	12	CC	P	35-53	10.0	1.0-1.2	10.0	2.6-3.0	15.0	12.0	1550	CVR
GEG-4801, A	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4802	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.

VR—Third brush and vibrating voltage regulator control.
CVR—Shunt Type—uses vibrating type current-voltage regulator.

N—Negative ground.
P—Positive ground.

GENERATOR SPECIFICATIONS

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GEG-4807A	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4809A	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4811A, B	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4812, -2	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	30.0	1375	CVR
GEG-4812X, XA	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4813	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4814	6	CC	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4815-1, M-1	6	CC	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	20.0	1300	CVR
GEG-4817-1	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	20.0	1300	CVR
GEG-4818, A, B, C	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4820-1	6	CC	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	20.0	1300	CVR
GEG-4821A, B	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4822	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4823, A, B, C, D, E, F	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4823BN	6	C	N	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4827-1	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	20.0	1300	CVR
GEG-4828-1	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	20.0	1300	CVR
GEG-4828N-1	6	C	N	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	20.0	1300	CVR
GEG-4830-1	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	20.0	1300	CVR
GEG-4831A	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4832A	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4833A	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4834	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-4835M, -1	6	CC	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	20.0	1300	CVR
GEG-4836	6	CC	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-5001A	6	C	N	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-5002, A, B, C, D, E, F	6	C	N	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-5004A	6	C	N	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-5005A	6	C	N	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-5101, A, C, D, E, F	6	C	N	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-5102C, E	6	C	N	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEG-6001A, B, C, D, S, S-1	6	C	P	64-68	5.0	1.3-1.5	5.0	4.2-4.7	8.0	40.0	1575	CVR
GEH-4801	12	CC	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	18.0	1250	CVR
GEH-4802	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	18.0	1250	CVR
GEH-4803-1	12	CC	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	10.0	1100	CVR
GEH-4804-1	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	10.0	1100	CVR
GEH-4806	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	18.0	1250	CVR
GEH-4807-1	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	10.0	1100	CVR
GEH-4808-1	12	CC	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	10.0	1100	CVR
GEH-4811	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	18.0	1250	CVR
GEH-4812	12	CC	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	18.0	1250	CVR
GEH-4813	12	CC	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	18.0	1250	CVR
GEH-4816	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	18.0	1250	CVR
GEH-4818M	12	CC	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	17.0	1225	CVR
GEH-4819-2	12	C	N	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-4820A-2	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-4821A-2, B-2	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-4822A-2, B-2	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-4823A	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	17.0	1225	CVR
GEH-4827M-1	12	CC	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	10.0	1100	CVR
GEH-4828M-1	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	10.0	1100	CVR
GEH-5001-2	12	C	N	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-5001P-2	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-5002-2	12	CC	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-5002-2N	12	CC	N	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-5004A-2	12	C	N	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-5101A-2	12	C	N	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEH-6001A, S	12	C	P	64-68	10.0	1.0-1.2	10.0	2.9-3.2	15.0	26.0	1500	CVR
GEJ-4801	6	C	N	35-53	5.0	1.3-1.5	5.0	2.9-3.3	8.0	16.0	1350	CVR
GEJ-4802-1	6	CC	P	35-53	5.0	1.3-1.5	5.0	2.9-3.3	8.0	20.0	1500	CVR

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.

CVR—Shunt Type—uses vibrating type current-voltage regulator.

N—Negative ground.
P—Positive ground.

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW Volts	FIELD COIL DRAW Amps.	MOTORING DRAW Volts	MOTORING DRAW Amps.	OUTPUT Volts	OUTPUT Max. Amps.	OUTPUT Max. R.P.M.	Control
GEJ-4805	6	C	P	35-53	5.0	1.3-1.5	5.0	2.9-3.3	8.0	16.0	1350	CVR
GEL-4802	12	C	P	35-53	10.0	2.2-2.5	10.0	3.1-3.5	15.0	10.0	......	CO
GEM-4102-1	6	C	P	15-20	5.0	3.4-3.8	5.0	3.2-3.6	8.0	10.0	......	TC
GEO-4801-3	6	CC	N	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	CO
GEO-4802-3	6	C	N	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	CO
GEO-4803-3	6	C	N	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	TC
GEO-4804-3	6	CC	N	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	CO
GEO-4805-3	6	C	P	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	CO
GEO-4806-3	6	CC	P	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	CO
GEO-4807-3	6	CC	N	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	CO
GEO-4808-3	6	CC	N	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	TC
GEO-4809-3	6	C	N	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	CO
GEO-4810, A	6	C	P	35-53	5.0	1.5-1.7	5.0	3.9-4.4	8.0	25.0	......	TC
GEO-4811	6	C	P	35-53	5.0	1.5-1.7	5.0	3.9-4.4	8.0	25.0	......	TC
GEO-4813	6	C	P	35-53	5.0	1.5-1.7	5.0	3.9-4.4	8.0	25.0	......	TC
GEO-4814-3	6	CC	P	35-53	5.0	1.5-1.7	5.0	3.0-3.4	8.0	19.0	......	CO
GEO-4815	6	CC	N	35-53	5.0	1.5-1.7	5.0	3.9-4.4	8.0	25.0	......	TC
GEO-4815P	6	CC	P	35-53	5.0	1.5-1.7	5.0	3.9-4.4	8.0	25.0	......	TC
GEO-4816A, AM	6	C	P	35-53	5.0	1.5-1.7	5.0	3.9-4.4	8.0	25.0	......	TC
GEO-4818A-3	6	C	P	35-53	5.0	1.5-1.7	5.0	4.0-4.9	8.0	19.0	......	CO
GEP-4801	6	C	P	35-53	5.0	1.3-1.5	5.0	4.6-4.8	8.0	20.0	......	CO or TC
GER-4801	6	C	P	35-53	5.0	1.3-1.5	5.0	4.6-5.2	8.0	40.5	......	VR
GES-4801	6	C	P	35-53	5.0	1.3-1.5	5.0	4.1-4.5	8.0	35.0	1600	CVR
GET-4501	12	C	N	7-10	10.0	1.5-1.8	10.0	1.8-2.0	15.0	11.0	......	CO
GET-4502	12	C	P	7-10	10.0	1.5-1.8	10.0	1.8-2.0	15.0	11.0	......	CO
GET-4503	12	C	N	7-10	10.0	1.5-1.8	10.0	1.8-2.0	15.0	11.0	......	CO
GEW-4801	6	CC	P	64-68	5.0	1.3-1.5	5.0	3.0-3.3	8.0	25.0	1050	CVR
GEW-4802	6	C	P	64-68	5.0	1.3-1.5	5.0	3.0-3.3	8.0	25.0	1050	CVR
GEW-4803, A	6	C	P	64-68	5.0	1.3-1.5	5.0	3.0-3.3	8.0	25.0	1050	CVR
GEW-4804	6	C	P	64-68	5.0	1.3-1.5	5.0	3.0-3.3	8.0	25.0	1050	CVR
GEW-4806, A, B, C	6	C	P	64-68	5.0	1.3-1.5	5.0	3.0-3.3	8.0	25.0	1050	CVR
GEY-4801	12	C	P	35-53	10.0	1.1-1.3	10.0	2.1-2.2	15.0	13.5	......	VR
GEZ-4801	12	CC	P	64-68	10.0	1.1-1.2	10.0	2.6-3.0	15.0	17.0	1250	CVR
GEZ-4802	12	CC	P	64-68	10.0	1.1-1.2	10.0	2.6-3.0	15.0	17.0	1250	CVR
GFA-4801-2, A-2, -2S	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4802-2	6	CC	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	CO
GFA-4803-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	CO
GFA-4804-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	CO
GFA-4805-2	6	CC	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	CO
GFA-4806-2, A-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4807-2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4808-2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4810-2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4811A-2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4812A-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4813-2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4814A-2, AM-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4816-2	6	CC	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	CO
GFA-4818-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4819-2	6	CC	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	CO
GFA-4820-2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	CO
GFA-4821-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4822-2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4823-2	6	CC	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	CO
GFA-4824-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4825-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4826-2	6	CC	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4828-2	6	CC	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4829-2	6	CC	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4830-2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4831-2	6	C	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4832-2	6	CC	N	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4833-2	6	CC	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFA-4834, -2	6	C	P	35-53	5.0	1.5-1.7	5.0	2.6-3.0	8.0	16.0	......	TC
GFB-4801-3	12	CC	P	35-53	10.0	1.9-2.1	10.0	3.1-3.5	15.0	15.0	......	CO

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.
TC—Third brush and two charge regulator control.
VR—Third brush and vibrating voltage regulator control.
CVR—Shunt Type—uses vibrating type current-voltage regulator.
N—Negative ground.
P—Positive ground.

GENERATOR SPECIFICATIONS

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GFB-4803-3	12	C	P	35-53	10.0	1.9-2.1	10.0	3.1-3.5	15.0	15.0	......	CO
GFB-4805-3, A-3	12	C	P	35-53	10.0	1.9-2.1	10.0	3.1-3.5	15.0	15.0	......	TC
GFB-4806-3	12	CC	P	35-53	10.0	1.9-2.1	10.0	3.1-3.5	15.0	15.0	......	TC
GFB-4807A-3	12	C	N	35-53	10.0	1.9-2.1	10.0	3.1-3.5	15.0	15.0	......	TC
GFB-4808A-3	12	C	P	35-53	10.0	1.9-2.1	10.0	3.1-3.5	15.0	15.0	......	CO
GFB-4809-3	12	C	P	35-53	10.0	1.9-2.1	10.0	3.1-3.5	15.0	15.0	......	TC
GFD-4801	12	C	P	15-20	10.0	1.7-2.0	10.0	2.8-3.2	15.0	13.5	......	TC
GFD-4802	12	C	P	15-20	10.0	1.7-2.0	10.0	2.8-3.2	15.0	13.5	......	TC
GFE-4801	6	CC	N	50-60	5.0	1.4-1.6	5.0	3.9-4.4	8.0	9.0	1250	VA
GFE-4802, A	6	C	N	50-60	5.0	1.4-1.6	5.0	3.9-4.4	8.0	9.0	1250	VA
GFE-4803	6	C	N	50-60	5.0	1.4-1.6	5.0	3.9-4.4	8.0	9.0	1250	VA
GFE-4804	6	R	N	50-60	5.0	1.4-1.6	5.0	3.9-4.4	8.0	9.0	1250	VA
GFF-4101	6	C	P	15-20	5.0	1.3-1.5	5.0	2.6-3.0	8.0	14.0	2175	CVR
GFF-4102	6	C	N	15-20	5.0	1.3-1.5	5.0	2.6-3.0	8.0	14.0	2175	CVR
GFG-4501	6	C	P	7-10	5.0	3.1-3.5	5.0	3.0-3.4	8.0	24.0	......	CO
GFH-4801A	6	C	N	35-53	5.0	2.4-2.7	5.0	4.2-4.7	8.0	28.0	......	TC
GFH-4802A	6	C	N	35-53	5.0	2.4-2.7	5.0	4.2-4.7	8.0	28.0	......	TC
GFJ-4802	12	CC	P	30-37	10.0	0.8-1.0	10.0	1.8-2.0	15.0	15.0	950	CVR
GFK-4802-1	12	C	N	30-37	10.0	1.1-1.2	10.0	2.6-2.9	15.0	30.0	1525	CVR
GFL-4801, S	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4802	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4803, A	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4805A	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4806, A, AM, M	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4807-1, M-1	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4808	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4809-1	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4810A, AM	24	C	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4811A	24	C	N	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFL-4812,-1, A, A-1	24	CC	P	35-53	20.0	0.6-0.8	20.0	1.2-1.4	30.0	5.0	1350	CVR
GFM-4801, A	12	C	N	30-37	10.0	1.0-1.2	10.0	5.0-5.7	15.0	50.0	1900	CVR
GFP-4801, A, B	6	C	P	30-37	5.0	1.4-1.5	5.0	2.9-3.2	8.0	40.0	1325	CVR
GFR-4801, A, B	24	CC	N	71-76	20.0	0.7-0.8	20.0	4.5-5.0	30.0	50.0	1675	CVR
GFR-4802, A, B	24	CC	N	71-76	20.0	0.7-0.8	20.0	4.5-5.0	30.0	50.0	1675	CVR
GFR-4803, A, B	24	CC	N	71-76	20.0	0.7-0.8	20.0	4.5-5.0	30.0	50.0	1675	CVR
GFR-4804A, B, C	24	CC	N	71-76	20.0	0.7-0.8	20.0	4.5-5.0	30.0	50.0	1675	CVR
GFR-4806	24	C	P	71-76	20.0	0.7-0.8	20.0	4.5-5.0	30.0	50.0	1675	CVR
GFR-4807	24	C	P	71-76	20.0	0.7-0.8	20.0	4.5-5.0	30.0	50.0	1675	CVR
GFR-4808A	24	C	P	71-76	20.0	0.7-0.8	20.0	4.5-5.0	30.0	50.0	1675	CVR
GFS-4801	12	C	P	35-53	10.0	1.1-1.2	10.0	2.7-3.0	15.0	12.0	1500	CVR
GFS-4802	12	CC	P	35-53	10.0	1.1-1.2	10.0	2.7-3.0	15.0	12.0	1500	CVR
GFU-4101	12	C	P	15-20	10.0	1.0-1.2	10.0	3.3-3.8	15.0	15.0	3050	CVR
GFU-4101N	12	C	N	15-20	10.0	1.0-1.2	10.0	3.3-3.8	15.0	15.0	3050	CVR
GFU-4102	12	C	P	15-20	10.0	1.0-1.2	10.0	3.3-3.8	15.0	15.0	3050	CVR
GFU-4102N	12	C	N	15-20	10.0	1.0-1.2	10.0	3.3-3.8	15.0	15.0	3050	CVR
GFU-4105	12	C	N	15-20	10.0	1.0-1.2	10.0	3.3-3.8	15.0	15.0	3050	CVR
GFW-4801A, B	12	C	P	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4802-1	12	C	P	35-53	10.0	1.8-2.1	10.0	2.6-2.9	15.0	14.0	......	TC
GFW-4803	12	CC	N	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4804	12	C	P	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4805	12	C	P	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	CO
GFW-4806	12	C	P	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4807	12	CC	P	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4808, M	12	C	N	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4809	12	C	N	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4810	12	CC	N	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	CO
GFW-4811	12	C	N	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4812	12	C	N	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	CO
GFW-4813-1	12	C	P	35-53	10.0	1.8-2.1	10.0	2.6-2.9	15.0	14.0	......	TC
GFW-4814A-1, B-1	12	C	P	35-53	10.0	1.8-2.1	10.0	2.6-2.9	15.0	14.0	......	TC
GFW-4815	12	C	N	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4816A-1	12	C	P	35-53	10.0	1.8-2.1	10.0	2.6-2.9	15.0	14.0	......	TC
GFW-4817A-1	12	CC	N	35-53	10.0	1.8-2.1	10.0	2.6-2.9	15.0	14.0	......	TC
GFW-4818A-1	12	C	P	35-53	10.0	1.8-2.1	10.0	2.6-2.9	15.0	14.0	......	TC
GFW-4820-1, A-1	12	C	P	35-53	10.0	1.8-2.1	10.0	2.6-2.9	15.0	14.0	......	TC

C—Clockwise rotation at the drive end.
CC—Counter Clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.
TC—Third brush and two charge regulator control.
CVR—Shunt Type—uses vibrating type current-voltage regulator.
VA—For batteryless system—uses vibrating voltage regulator only.
N—Negative ground.
P—Positive ground.
R—Reversible.

Auto-Lite Electrical Equipment

GENERATOR	Rated Volts	Rot. D. E.	Ground Polarity	Brush Spring Tension Ounces	FIELD COIL DRAW		MOTORING DRAW		OUTPUT			Control
					Volts	Amps.	Volts	Amps.	Volts	Max. Amps.	Max. R.P.M.	
GFW-4821	12	C	P	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4822A	12	C	P	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFW-4823	12	C	P	35-53	10.0	1.8-2.1	10.0	2.1-2.4	15.0	10.0	......	TC
GFY-4801	6	CC	N	30-37	5.0	1.4-1.6	5.0	4.9-6.8	8.0	22.5	875	VA
GFY-4802	6	CC	N	30-37	5.0	1.4-1.6	5.0	4.9-6.8	8.0	22.5	875	VA
GFZ-4801A, B	24	C	N	71-76	20.0	0.7-0.8	20.0	2.5-2.9	30.0	25.0	1000	CVR
GGA-4801A	12	C	N	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4802, AM	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4803	12	CC	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4805A, B	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4807	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4808A	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4810	12	CC	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4812A	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4813	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4814, A, B, C, D, E	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGA-4816	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	35.0	1500	CVR
GGA-6001A, B, S	12	C	P	30-37	10.0	1.1-1.3	10.0	2.3-2.6	15.0	40.0	1600	CVR
GGB-4101	6	C	..	15-20	5.0	2.1-2.4	5.0	5.4-6.0	8.0	5.0	2600	CVR
GGC-4802A, B, S	12	C	N	35-53	10.0	1.0-1.2	10.0	3.6-4.3	15.0	8.0	1250	CVR
GGE-4801M	6	C	P	35-53	5.0	1.3-1.5	5.0	3.0-3.5	8.0	14.0	1325	CVR
GGE-4802M	6	CC	P	35-53	5.0	1.3-1.5	5.0	3.0-3.5	8.0	14.0	1325	CVR
GGE-4803	6	C	P	35-53	5.0	1.3-1.5	5.0	3.0-3.5	8.0	14.0	1325	CVR
GGE-4804M	6	C	P	35-53	5.0	1.3-1.5	5.0	3.0-3.5	8.0	14.0	1325	CVR
GGE-4805M	6	CC	P	35-53	5.0	1.3-1.5	5.0	3.0-3.5	8.0	14.0	1325	CVR
GGE-4806A, B	6	C	N	35-53	5.0	1.3-1.5	5.0	4.0-5.0	8.0	14.0	1325	CVR
GGE-4806C	6	C	P	35-53	5.0	1.3-1.5	5.0	4.0-5.0	8.0	14.0	1325	CVR
GGE-4807M	6	C	P	35-53	5.0	1.3-1.5	5.0	3.0-3.5	8.0	14.0	1325	CVR
GGE-4808M	6	CC	P	35-53	5.0	1.3-1.5	5.0	3.0-3.5	8.0	14.0	1325	CVR
GGF-4801	24	C	P	64-68	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	1375	CVR
GGF-4802	24	C	P	64-68	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	1375	CVR
GGF-4803A	24	C	P	64-68	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	1375	CVR
GGF-4805A	24	C	P	64-68	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	1375	CVR
GGF-5101A	24	C	N	64-68	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	1375	CVR
GGF-6001A, B, S	24	C	P	64-68	20.0	0.7-0.8	20.0	1.8-2.1	30.0	10.0	1375	CVR
GGG-4801M	12	C	P	35-53	10.0	1.0-1.2	10.0	2.7-3.1	15.0	10.0	1325	CVR
GGG-4802M	12	CC	P	35-53	10.0	1.0-1.2	10.2	2.7-3.1	15.0	10.0	1325	CVR
GGG-4803	12	CC	P	35-53	10.0	1.0-1.2	10.2	2.7-3.1	15.0	10.0	1325	CVR
GGH-4501	6	C	N	7-10	5.0	1.0-1.2	5.0	1.4-1.6	8.0	15.5	......	CO
GGJ-4801A	6	C	P	30-37	5.0	1.4-1.6	5.0	3.7-4.2	8.0	50.0	1600	CVR
GGJ-4802A, AX	6	C	P	30-37	5.0	1.4-1.6	5.0	3.7-4.2	8.0	50.0	1600	CVR
GGJ-4803A, B	6	C	P	30-37	5.0	1.4-1.6	5.0	3.7-4.2	8.0	50.0	1600	CVR
GGJ-4804A, B	6	C	P	30-37	5.0	1.4-1.6	5.0	3.7-4.2	8.0	50.0	1600	CVR
GGJ-6001A,B,C, D,E,F,G,S,S-1	6	C	P	30-37	5.0	1.4-1.6	5.0	3.7-4.2	8.0	50.0	1600	CVR
GGJ-6002,A,B,S,S-1	6	C	P	30-37	5.0	1.4-1.6	5.0	3.7-4.2	8.0	50.0	1600	CVR
GGJ-6101A,C,S	6	C	P	30-37	5.0	1.4-1.6	5.0	3.7-4.2	8.0	50.0	1600	CVR
GGK-4501	6	C	P	7-10	5.0	3.0-3.3	5.0	3.6-4.2	8.0	30.0	......	CO
GGL-4501	12	C	P	7-10	10.0	1.4-1.6	10.0	1.7-2.0	15.0	15.0	......	CO
GGM-4801A	6	C	P	50-60	5.0	1.2-1.6	5.0	4.1-4.6	8.0	15.5	1700	VA
GGO-4801	12	CC	P	30-37	10.0	1.2-1.3	10.0	2.3-2.6	15.0	20.0	1050	CVR
GGO-6001A,S	12	C	P	30-37	10.0	1.2-1.3	10.0	1.4-1.7	15.0	20.0	1050	CVR
GGP-4801A,B	6	C	P	35-53	5.0	1.4-1.6	5.0	4.1-5.1	8.0	14.0	1350	CVR
GGR-4801A	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.5	5.0	5.9-7.2	8.0	15.0	......	CO
GGR-4802A	6	C	P	Main 37-44 Third 50-60	5.0	3.2-3.5	5.0	5.9-7.2	8.0	15.0	......	TC
GGS-4801A	12	C	N	35-53	10.0	1.0-1.2	10.0	4.0-4.6	15.0	35.0	2800	CVR
GGU-6001A,B,C,D,E,F, G,H,J,K,S,S-1	6	C	P	35-53	5.0	1.4-1.6	5.0	5.0-6.0	8.0	45.0	1650	CVR
GGU-6002A,S,S-1	6	C	P	35-53	5.0	1.4-1.6	5.0	5.0-6.0	8.0	45.0	1650	CVR
GGW-6001A,B,C,D,E,F, G,H,J,K,L,P,S,S-1	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.5	8.0	40.0	2000	CVR
GGW-6002A,B,S,S-1	6	C	P	35-53	5.0	1.3-1.5	5.0	3.9-4.5	8.0	40.0	2000	CVR
GGZ-6001A,B,S-1	6	C	P	35-53	5.0	1.4-1.6	....	....	8.0	35.0	......	CVR

C—Clockwise rotation at the drive end.
CC—Counter clockwise rotation at the drive end.
CO—Third brush control—uses cut-out relay only.

TC—Third brush and two charge regulator control.
VA—For batteryless system—uses vibrating voltage regulator only.
CVR—Shunt Type—uses vibrating type current-voltage regulator.

P—Positive ground.
N—Negative Ground.

VOLTAGE TESTS

These figures are for a unit in normal operation while charging at ½ maximum output.

Test No		OPERATING VOLTAGES								*Tolerance*
		50° F.	*60° F.*	*70° F.*	*80° F.*	*90° F.*	*100° F.*	*110° F.*	*120° F.*	
1	Contacts open	8.65	8.57	8.50	8.43	8.35	8.28	8.21	8.14	±.25
	Contacts close	7.20	7.12	7.05	6.97	6.90	6.83	6.76	6.69	±.20
2	Contacts open	8.25	8.17	8.10	8.03	7.95	7.88	7.81	7.74	±.15
	Contacts close	6.48	6.41	6.35	6.28	6.21	6.15	6.09	6.02	±.15
3	Contacts open	17.30	17.14	17.00	16.86	16.70	16.56	16.42	16.26	±.40
	Contacts close	14.40	14.25	14.10	13.95	13.80	13.65	13.50	13.35	±.40
4	Contacts open	15.95	15.80	15.65	15.50	15.35	15.20	15.05	14.90	±.20
	Contacts close	13.35	13.20	13.05	12.90	12.75	12.60	12.45	12.30	±.25
5	Contacts open	15.06	14.92	14.80	14.66	14.54	14.42	14.30	14.18	±.30
	Contacts close	12.16	12.02	11.90	11.76	11.62	11.50	11.38	11.26	±.30
6	Contacts open	8.39	8.32	8.25	8.18	8.11	8.04	7.97	7.90	±.25
	Contacts close	6.94	6.87	6.80	6.73	6.66	6.59	6.52	6.45	±.20
7	Contacts open	7.34	7.29	7.25	7.21	7.16	7.12	7.08	7.04	±.15
	Contacts close	6.24	6.19	6.15	6.11	6.06	6.02	5.98	5.94	±.15
8	Contacts open	7.78	7.71	7.65	7.58	7.52	7.46	7.40	7.35	±.20
	Contacts close	6.48	6.41	6.35	6.28	6.21	6.15	6.09	5.99	±.15
9	Contacts open	7.53	7.46	7.40	7.33	7.27	7.21	7.15	7.08	±.15
	Contacts close	6.28	6.21	6.15	6.08	6.01	5.95	5.89	5.83	±.15
10	Contacts open	14.64	14.57	14.50	14.43	14.36	14.29	14.22	14.15	±.25
	Contacts close	14.79	14.72	14.65	14.58	14.51	14.44	14.37	14.30	±.25
11	Contacts open	......	......	9.00	......	......	......	......	......	±.25
	Contacts close	......	......	7.05	......	......	......	......	......	±.15
12		6.71	6.68	6.65	6.62	6.59	6.56	6.53	6.50	±.15
13		......	......	5.25	......	......	......	......	......	±.25
14		7.41	7.38	7.35	7.32	7.29	7.26	7.23	7.20	±.15
15		14.31	14.28	14.25	14.22	14.19	14.16	14.13	14.10	±.25
16		28.58	28.54	28.50	28.46	28.42	28.38	28.34	28.30	±.40
17		29.08	29.04	29.00	28.96	28.92	28.88	28.84	28.80	±.40
18		38.10	38.05	38.00	37.95	37.90	37.85	37.80	37.75	±.50
19		7.16	7.13	7.10	7.07	7.04	7.01	6.98	6.95	±.10
20		......	......	6.20	......	......	......	......	......	±.20
21		29.38	29.34	29.30	29.26	29.22	29.18	29.14	29.10	±.40
22		14.53	14.52	14.50	14.49	14.47	14.46	14.44	14.43	±.25
23		28.84	28.67	28.50	28.33	28.16	27.99	27.82	27.65	±.25
24		14.59	14.54	14.50	14.46	14.42	14.37	14.33	14.29	±.30
25		14.09	14.04	14.00	13.96	13.92	13.87	13.83	13.79	±.20
26		29.34	29.17	29.00	28.82	28.65	28.48	28.31	28.19	±.70
27		37.90	37.60	37.30	37.00	36.70	36.40	36.10	35.80	±1.50
28		7.63	7.56	7.50	7.44	7.37	7.31	7.24	7.18	±.15
29		14.76	14.73	14.70	14.67	14.64	14.61	14.58	14.55	±.25
30		27.84	27.67	27.50	27.32	27.15	26.98	26.81	26.64	±.30
31		7.34	7.29	7.25	7.21	7.16	7.12	7.08	7.04	±.15

CURRENT TESTS

Most current regulators are set within the limits tabulated for the various units; however, only a nominal setting is given for temperature compensated current regulators. On this type, the current regulator should operate as given in test "A" below after the voltage check at 1/2 maximum output for 15 minutes. After an additional 15 minutes operation on the current regulator, the setting should be as given in test "B".

TEMPERATURE

NOMINAL SETTING		*40° F.*	*60° F.*	*70° F.*	*80° F.*	*100° F.*
35	Test A	45 Max.	43 Max.	42 Max.	41 Max.	39 Max.
	Test B	36-40	34-38	33-37	32-36	30-34
40	Test A	49 Max.	47 Max.	46 Max.	45 Max.	43 Max.
	Test B	41-45	39-43	38-42	37-41	35-39
45	Test A	53 Max.	51 Max.	50 Max.	49 Max.	47 Max.
	Test B	46-50	44-48	43-47	42-46	40-44
50	Test A	58 Max.	56 Max.	55 Max.	54 Max.	52 Max.
	Test B	51-55	49-53	48-52	47-51	45-49

PART NUMBER	Rated Volts	Ground Polarity	ARMATURE AIR GAPS			CONTACT GAPS		CUT-OUT RELAY		Voltage Reg. Test	Current Reg. Amperes
			Cut-Out Relay Inches	Voltage Reg. Inches	Current Reg. Inches	Cut-Out Relay Inches	Voltage Reg. Inches	Closes Volts	Opens Volts or Amps.		
CB-4007	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4008, M	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4012, A, AM	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4013	12	..	.010-.030*	.....	.....	.015-.045	.....	13.0-14.5	0.5-2.0A.	..	.....
CB-4014, A, B, C	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4020S	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4021, S	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4023	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4024	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4025	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
CB-4026	12	..	.010-.030*	.....	.....	.015-.045	.....	13.0-14.5	0.5-2.0A.	..	.....
CB-4027	12	..	.010-.030*	.....	.....	.015-.045	.....	13.0-14.5	0.5-2.0A.	..	.....
CB-4028	12	..	.010-.030*	.....	.....	.015-.045	.....	13.0-14.5	0.5-2.0A.	..	.....
CBA-4003	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	1.5-4.5A.	..	.....
CBA-4004	12	..	.010-.030*	.....	.....	.015-.045	.....	13.0-14.5	0.5-3.5A.	..	.....
CBA-4005, A	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	1.5-4.5A.	..	.....
CBB-4001	24	..	.010-.030*	.....	.....	.015-.045	.....	26.0-29.0	0.5-1.5A.	..	.....
CBC-4001	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.0	0.0-1.0A.	..	.....
CBD-4001	12	..	.010-.030*	.....	.....	.015-.045	.....	13.0-14.0	0.0-1.0A.	..	.....
CBK-4001	6	..	.034-.038	.....	.....	.015 min.	. ..	6.9-7.3	0.5-1.5A.	..	.....
CBO-4001	12	..	.034-.038	.....	.....	.015 min.	.....	14.5-15.0	0.5-1.5A.	..	.....
CBR-4001	32	..	.060-.065	.....	.....	.025 min.	.....	39.0-41.0	0.5-1.0A.	..	.....
RA-4001A	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
RA-4002	12	..	.010-.030*	.....	.....	.015-.045	.....	13.0-14.5	0.5-2.0A.	..	.....
RA-4005	6	..	.010-.030*	.....	.....	.015-.045	.....	6.5-7.25	0.5-2.5A.	..	.....
TC-4301A, B, C	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4301D, E, F	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	2	.....
TC-4302A, B	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4302C	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	2	.....
TC-4303A, B, C	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	3	.....
TC-4303D, -2	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	4	.....
TC-4303D-1	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	5	.....
TC-4303E, F	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	3	.....
TC-4304A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	6	.....
TC-4305A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4305B	6	..	.010-.030*	.034-.038	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	2	.....
TC-4305C, D, E	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	2	.....
TC-4305G	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	2	.....
TC-4306A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4307A	6	..	......	.044-.046	.....	.....	.005 min.	.....	.....	6	.....
TC-4309A	6	..	......	.044-.046	.....	.....	.005 min.	.....	.....	1	.....
TC-4310A, B	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	3	.....
TC-4312A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4313A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4317A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4318A	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	3	.....
TC-4320A, B	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4321A	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	3	.....
TC-4322A	12	..	......	.044-.046	.....	.....	.005 min.	.....	.....	3	.....
TC-4323A, B, C	6	..	.010-.030*	.047-.049	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	7	.....
TC-4324A, AM	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	2	.....
TC-4326A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	8	.....
TC-4326B	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-6.9	1.0-3.5A.	9	.....
TC-4327A, B, C, D	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-6.9	1.0-3.5A.	9	.....
TC-4327E, EM, F	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	8	.....
TC-4328A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	1	.....
TC-4329A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	8	.....
TC-4329B, C	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-6.9	1.0-3.5A.	9	.....
TC-4331A, B	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	4	.....
TC-4332A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	8	.....

* Measure when contacts are closed.

REGULATOR TEST SPECIFICATIONS

PART NUMBER	Rated Volts	Ground Polarity	ARMATURE AIR GAPS			CONTACT GAPS		CUT-OUT RELAY		Voltage Reg. Test	Current Reg. Amperes
			Cut-Out Relay Inches	Voltage Reg. Inches	Current Reg. Inches	Cut-Out Relay Inches	Voltage Reg. Inches	Closes Volts	Opens Volts or Amps.		
TC-4333A	6	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	6.4-7.0	1.0-3.0A.	8	.....
TC-4401AM	6	..	.010-.030*	.047-.049	.....	.015-.045	.005 min.	6.5-7.25	1.0-3.0A.	7	.....
TC-4402AM	12	..	.010-.030*	.044-.046	.....	.015-.045	.005 min.	12.8-13.8	0.5-2.0A.	4	.....
TCA-4001	12	..	......	.044-.046	.....	.....	.005 min.	.....	.....	10	.....
TCA-4002	12	..	......	.044-.046	.....	.....	.005 min.	.....	.....	10	.....
TCA-4003M	12	..	......	.044-.046	.....	.....	.005 min.	.....	.....	10	.....
TCB-4001	6	..	.032-.036	.044-.046	.....	.015 min.	.005 min.	6.75-7.25	1.0-4.5A.	11	.....
TCC-4001	6	..	......	.044-.046	.....	.....	.005 min.	.....	.....	8	.....
†VAA-4001	6	N	......	.048-.052	.....	.....	.....	.....	.....	12	.....
†VAA-4002	6	N	......	.048-.052	.....	.....	.....	.....	.....	12	.....
†VAA-4003	6	N	......	.048-.052	.....	.....	.....	.....	.....	12	.....
†VAA-4101	6	P	......	.048-.052	.....	.....	.....	.....	.....	12	.....
†VAA-4102	6	N	......	.048-.052	.....	.....	.....	.....	.....	13	.....
†VAA-4103	6	N	......	.048-.052	.....	.....	.....	.....	.....	13	.....
†VAA-4104	6	N	......	.048-.052	.....	.....	.....	.....	.....	13	.....
VAB-4001A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	13.0-15.0
VAB-4002A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	13.0-15.0
VAC-4001A	12	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	29.0-31.0
VAC-4002A	12	N	.060-.065	.040-.049	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	29.0-31.0
VAD-4103A	24	N	.095-.100	.040-.042	.047-.049	.095-.100	.....	25.7-26.7	16-21A.	16	50.0-53.0
VAD-4104A	24	N	.095-.100	.040-.042	.047-.049	.095-.100	.....	25.7-26.7	16-21A.	17	50.0-53.0
VAD-4105A	24	N	.095-.100	.040-.042	.047-.049	.095-.100	.....	25.7-26.7	16-21A.	16	50.0-53.0
VAD-4106A, B, C	24	N	.095-.100	.040-.042	.047-.049	.080-.130	.....	25.7-26.7	16-21A.	17	50.0-53.0
VAD-4109A	24	P	.095-.100	.040-.042	.047-.049	.080-.130	.....	25.7-26.7	16-21A.	16	50.0-53.0
VAE-4101A	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	24.0-26.0
VAF-4101A	32	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	34.8-36.2	0.5-2.5A.	18	7.0-7.5
VAF-4103A	32	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	34.8-36.2	0.5-2.5A.	18	9.7-10.3
VAG-4101A	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-4.0A.	15	18.0-19.0
VAG-4101B	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-4.0A.	15	24.0-25.0
VAH-4001A	24	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	26.0-27.2	1.7-3.8A.	16	9.8-10.2
VAJ-4001A	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	99-101
‡VAK-4001	6	N	......	.048-.052	.....	.....	.....	.....	.....	20	.....
+VAK-4002	6	N	......	.048-.052	.....	.....	.....	.....	.....	20	.....
VAM-4101A	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	39.0-41.0
VAM-4101B	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	22	39.0-41.0
VAO-4001†AM	24	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	26.0-27.2	3.0-5.0A.	21	25.0-27.0
VAP-4001	6	N	......	.048-.052	.....	.....	.....	.....	.....	14	.....
VAR-4001	24	..	......	.048-.052	.....	.....	.....	.....	.....	23	.....
VAS-4001A	24	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	26.0-27.2	1.7-3.8A.	16	9.8-10.2
VAT-4001A	12	P	.031-.034	.048-.052	.015 min.	.....	.....	13.0-13.75	8.2-9.3V.	24	39.0-41.0
VAT-4002A, AX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3V.	25	39.0-41.0
VAT-4003A	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3V.	24	39.0-41.0
VAT-4004AX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3V.	25	39.0-41.0
VAT-4101AM	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3V.	24	39.0-41.0
VAU-4001A	24	N-P	.048-.052	.048-.052	.048-.052	.015 min.	.....	26.0-27.5	2.0-6.0A.	26	12.5-13.5
VAV-4001A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	49.0-51.0
VAV-4002A, B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	49.0-41.0
VAV-4002C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	44.0-46.0
VAV-4401A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	49.0-51.0
VAV-4401B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8V.	14	44.0-46.0
VAV-4402A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	50 §
VAV-4403A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	50 §
VAV-4404A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	50 §
VAV-4404B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	45 §
VAV-4405A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	50 §
VAV-4405B	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8V.	14	45§
VAV-6001A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.3-6.8	4.1-4.8V.	31	45§
VAV-6002A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.3-6.8	4.1-4.8V.	31	45§
VAW-4001	32	..	......	.....	.....	.....	.....	.....	.....	27	.....
VAX-4001A	24	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	26.0-27.2	1.7-3.8A.	16	14.0-16.0

† For batteryless operation. Set voltage regulator with 67 c. p. lamp load. *** Measure when contacts are closed.**
‡ For batteryless operation. Set voltage regulator with 5 amperes load and with 22.5 amperes load.
+ For batteryless operation. Set voltage regulator with 1 ampere load and with 8.5 amperes load.
§ Nominal amperage for this current regulator which is temperature compensated.
See table for operating current at the various temperatures.

N—Negative ground.
P—Positive ground.

PART NUMBER	Rated Volts	Ground Polarity	ARMATURE AIR GAPS			CONTACT GAPS		CUT-OUT RELAY		Voltage Reg. Test	Current Reg. Amperes
			Cut-Out Relay Inches	Voltage Reg. Inches	Current Reg. Inches	Cut-Out Relay Inches	Voltage Reg. Inches	Closes Volts	Opens Volts or Amps.		
VBA-4001A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	19	48.0-52.0
VBA-4101A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	19	50 §
VBA-4101B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	45 §
VBA-4102A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	50 §
VBA-4103A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	50 §
VBA-4104A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	50 §
VBA-4104B	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	45 §
VBA-4202A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.3-6.8	4.1-4.8V.	31	50 §
VBA-4203A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.3-6.8	4.1-4.8V.	31	35 §
VBA-4204A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.3-6.8	4.1-4.8V.	31	50 §
VBA-4205A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	50 §
VBA-4206A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	50 §
VBA-6001A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	45 §
VBB-4001A	6	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0A.	14	58.0-62.0
VBD-4001A	6	P	......	.048-.052	.....	.....	.....	.....	.....	12	.....
VRA-4102A	12	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	39.0-41.0
VRA-4105A	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	39.0-41.0
VRB-4002A	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	29.0-31.0
VRB-4002C	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	24.0-26.0
VRB-4002D	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	27.0-29.0
VRB-4003A	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	21.0-23.0
VRB-4004A	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	29.0-31.0
VRB-4004B	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	27.0-29.0
VRB-4004C	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	24.0-26.0
VRB-4005A	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	21.0-23.0
VRB-4006A	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	11.0-13.0
VRB-4007A	6	N	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	29.0-31.0
VRB-4008A, AP	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	29.0-31.0
VRB-4008B	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	24.0-26.0
VRB-4008D	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	19.0-21.0
VRB-4008E	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	31.0-33.0
VRB-4009A	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	24.0-26.0
VRB-4010A	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	27.0-29.0
VRB-4012A-1	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	27.0-29.0
VRB-4012B-1	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	34.0-36.0
VRC-4101A	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0A.	14	39.0-41.0
VRC-4101B	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0A.	14	49.0-51.0
VRC-4101C	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0A.	14	44.0-46.0
VRC-4102A	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0A.	14	39.0-41.0
VRC-4102B	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0A.	14	29.0-31.0
VRC-4103A	6	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0A.	14	49.0-51.0
VRD-4001A, B	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	.....
VRD-4002A, B	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	.....
VRD-4003A	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	.....
VRD-4003B	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	28	.....
VRD-4004A	6	N	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	.....
VRD-4005A	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	.....
VRD-4006A, B	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	.....
VRD-4008A, B	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.0-6.0A.	28	.....
VRD-4009A	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	.....
VRD-4010A	6	P	.034-.038	.060-.062	.....	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	.....
VRE-4001A	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	14.0-16.0
VRE-4001B	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	11.0-13.0
VRE-4001C	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	16.0-18.0
VRE-4002A	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	14.0-16.0
VRE-4002B	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	16.0-18.0
VRE-4002C	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	19.0-21.0
VRE-4002D	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	11.0-13.0
VRE-4003A, -1	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	14.0-16.0
VRE-4004A	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	14.0-16.0

§ Nominal amperage for this current regulator which is temperature compensated. See table for operating current at the various temperatures.

P—Positive ground.
N—Negative Ground.

REGULATOR TEST SPECIFICATIONS

PART NUMBER	Rated Volts	Ground Polarity	ARMATURE AIR GAP			CONTACT GAPS		CUT-OUT RELAY		Voltage Reg. Test	Current Reg. Amperes
			Cut-Out Relay Inches	Voltage Reg. Inches	Current Reg. Inches	Cut-Out Relay Inches	Voltage Reg. Inches	Closes Volts	Opens Volts or Amps.		
VRE-4005A	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	14.0-16.0
VRF-4001A	12	P	.034-.038	.060-.065	.....	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	.....
VRF-4003A	12	P	.034-.038	.060-.065	.....	.015 min.	.....	13.0-13.75	0.0-5.0A.	24	.....
VRF-4004A	12	P	.034-.038	.060-.065	.....	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	.....
VRF-4005A	12	P	.034-.038	.060-.065	.....	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	.....
VRF-4006A	12	P	.034-.038	.060-.065	.....	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	.....
VRF-4007A	12	P	.034-.038	.060-.065	.....	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	.....
VRG-4101A	12	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	32.0-34.0
VRG-4102A	12	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	32.0-34.0
VRG-4102B, C	12	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	22	25.0-27.0
VRG-4102D	12	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	25.0-27.0
VRG-4103A	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	19.0-21.0
VRG-4103B	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	25.0-27.0
VRG-4103C	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	34.0-36.0
VRG-4103D	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	25.0-27.0
VRG-4104A	12	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	39.0-41.0
VRG-4105A	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	19.0-21.0
VRG-4105B	12	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	25.0-27.0
VRG-4106A	12	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	25.0-27.0
VRH-4101A	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	54.0-56.0
VRH-4101B, C	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	49.0-51.0
VRH-4102A, B	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	54.0-56.0
VRH-4103A, -1	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	54.0-56.0
VRH-4104A-1	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	54.0-56.0
VRH-4104B-1	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	29	54.0-56.0
VRH-4104C-1, D-1	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	54.0-56.0
VRH-4104E-1	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	29	54.0-56.0
VRH-4104F-1	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	22	54.0-56.0
VRH-4105A	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	49.0-51.0
VRH-4106A	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	54.0-56.0
VRH-4106B	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	49.0-51.0
VRH-4107A-1M	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	29	54.0-56.0
VRH-4107B-1M	12	N-P	.060-.065	.040-.042	.047-.049	.025 min.	.....	13.0-13.5	0.5-6.0A.	15	54.0-56.0
VRJ-4001A	6	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	39.0-41.0
VRJ-4002A	6	N	.034-.038	.060-.062	.060-.062	.015 min.	.....	6.4-7.0	0.5-3.0A.	14	39.0-41.0
VRK-4001A	24	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	25.0-25.75	0.5-2.0A.	30	9.8-10.2
VRO-4001A	12	P	.034-.038	.060-.062	.060-.062	.015 min.	.....	13.0-13.75	0.5-3.0A.	24	29.0-31.0
VRP-4001A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4001AX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	34.0-36.0
VRP-4001B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	31.0-33.0
VRP-4001C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	27.0-29.0
VRP-4001D	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	29.0-31.0
VRP-4001E	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	24.0-26.0
VRP-4001F, G	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4002A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4002B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	27.0-29.0
VRP-4002C, D	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4003A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4004A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4004B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	29.0-31.0
VRP-4004C, -1	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	31.0-33.0
VRP-4004CX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	31.0-33.0
VRP-4004D	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	27.0-29.0
VRP-4004E	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4004F, -1, -2	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4004FX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	34.0-36.0
VRP-4004G	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	24.0-26.0
VRP-4004H	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	29.0-31.0
VRP-4004J	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4004K	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0

N—Negative ground.
P—Positive ground.

PART NUMBER	Rated Volts	Ground Polarity	ARMATURE AIR GAP			CONTACT GAPS		CUT-OUT RELAY		Voltage Reg. Test	Current Reg. Amperes
			Cut-Out Relay Inches	Voltage Reg. Inches	Current Reg. Inches	Cut-Out Relay Inches	Voltage Reg. Inches	Closes Volts	Opens Volts or Amps.		
VRP-4005A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4005B	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	31.0-33.0
VRP-4005C	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	24.0-26.0
VRP-4005D	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	27.0-29.0
VRP-4005E	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4006A, AP	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	29.0-31.0
VRP-4006B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	24.0-26.0
VRP-4006C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	27.0-29.0
VRP-4006D	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	29.0-31.0
VRP-4006E	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	31.0-33.0
VRP-4006F	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4006G	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	24.0-26.0
VRP-4006H	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4006J	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4007A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	31.0-33.0
VRP-4007B	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4007C, -1, -2	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4007D	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	29.0-31.0
VRP-4008A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	28	39.0-41.0
VRP-4008B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	28	34.0-36.0
VRP-4008C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	28	31.0-33.0
VRP-4008D	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	28	34.0-36.0
VRP-4009A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	29.0-31.0
VRP-4009B	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	27.0-29.0
VRP-4009C	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4009D	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	24.0-26.0
VRP-4010A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	31.0-33.0
VRP-4011	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4101A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	21.0-23.0
VRP-4102A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	21.0-23.0
VRP-4102AX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	21.0-23.0
VRP-4103A, B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	19.0-21.0
VRP-4104A, B, B-1	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	19.0-21.0
VRP-4105A, AM	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	19.0-21.0
VRP-4106A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	19.0-21.0
VRP-4106B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	21.0-23.0
VRP-4107A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	19.0-21.0
VRP-4201A-1	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4202A-1	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4301AM	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4302AM, BM	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	16.0-18.0
VRP-4303AM	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8V.	14	31.0-33.0
VRP-4303AXM	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	34.0-36.0
VRP-4303BM	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8V.	14	24.0-26.0
VRP-4304AM	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	16.0-18.0
VRP-4401A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4401AX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	34.0-36.0
VRP-4401B, C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4401D	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	31.0-33.0
VRP-4402A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	34.0-36.0
VRP-4402B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4402C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8V.	14	39.0-41.0
VRP-4403A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	39.0-41.0
VRP-4405A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8V.	14	31.0-33.0
VRP-4501A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	35§
VRP-4501AX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	35§
VRP-4501C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	40§
VRP-4502A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	40§
VRP-4503A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8V.	14	35§
VRP-4503AX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8V.	19	35§

**§ Nominal amperage for this current regulator which is temperature compensated.
See table for operating current at the various temperatures.**

**N—Negative ground.
P—Positive ground.**

REGULATOR TEST SPECIFICATIONS

PART NUMBER	Rated Volts	Ground Polarity	ARMATURE AIR GAP			CONTACT GAPS		CUT-OUT RELAY		Voltage Reg. Test	Current Reg. Amperes
			Cut-Out Relay Inches	Voltage Reg. Inches	Current Reg. Inches	Cut-Out Relay Inches	Voltage Reg. Inches	Closes Volts	Opens Volts or Amps.		
VRP-4503B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	40§
VRP-4503BX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8 V.	19	40§
VRP-4503C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8 V.	14	35§
VRP-6001A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8 V.	14	34.0-36.0
VRP-6001B	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8 V.	14	39.0-41.0
VRP-6002A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8 V.	14	34.0-36.0
VRP-6003A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8 V.	14	34.0-36.0
VRP-6004A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8 V.	14	40§
VRR-4001A, B	6	P	.031-.034	.048-.052	.....	.015 min.	.....	6.4-7.0	4.1-4.8 V.	28	.....
VRR-4002A, B	6	P	.031-.034	.048-.052	.....	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	.....
VRR-4003A	6	P	.031-.034	.048-.052	.....	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	.....
VRR-4004A, B	6	N	.031-.034	.048-.052	.....	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	.....
VRR-4005A	6	P	.031-.034	.048-.052	.....	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	.....
VRR-4006A	6	P	.031-.034	.048-.052	.....	.015 min.	.....	6.4-7.0	4.1-4.8 V.	28	.....
VRR-4007A	6	N	.031-.034	.048-.052	.....	.015 min.	.....	6.4-7.0	4.1-4.8 V.	28	.....
VRR-4008A, AX	6	P	.031-.034	.048-.052	.....	.015 min.	.....	6.35-6.75	4.1-4.8 V.	19	.....
VRR-5008, AX	6	P	.031-.034	.048-.052	.....	.015 min.	.....	6.35-6.75	4.1-4.8 V.	19	.....
VRS-4001A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4001B	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	17.0-19.0
VRS-4001C	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	11.0-13.0
VRS-4002A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4003A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4004A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4004B, C	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	16.0-18.0
VRS-4004D	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	17.0-19.0
VRS-4004E	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	9.0-11.0
VRS-4004F	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	17.0-19.0
VRS-4004G	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	11.0-13.0
VRS-4004H	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	19.0-21.0
VRS-4005A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4005B	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	16.0-18.0
VRS-4005C	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	19.0-21.0
VRS-4005D	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	11.0-13.0
VRS-4005E	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	9.0-11.0
VRS-4006A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4006B	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	11.0-13.0
VRS-4006C	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	16.0-18.0
VRS-4007A, -1	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4007B	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	9.0-11.0
VRS-4007C	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4007D	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	19.0-21.0
VRS-4008A	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4009A	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	17.0-19.0
VRS-4010A	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	17.0-19.0
VRS-4010B	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4012A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	11.0-13.0
VRS-4013A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	17.0-19.0
VRS-4014A	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	14.0-16.0
VRS-4015AX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	19.0-21.0
VRS-4102AM	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	17.0-19.0
VRS-4102BM	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	11.0-13.0
VRS-4102CM	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	17.0-19.0
VRS-4102DM	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	9.0-11.0
VRS-4102EM	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	11.0-13.0
VRS-4102FM, FMT	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	16.0-18.0
VRS-4103AM	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	11.0-13.0
VRS-4103BM	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	9.0-11.0
VRS-4201A, AX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	11.0-13.0
VRS-5001	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	16.0-18.0
VRS-5004C	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	16.0-18.0

§ Nominal amperage for this current regulator which is temperature compensated. See table for operating current at the various temperatures.

N—Negative ground.
P—Positive ground.

PART NUMBER	Rated Volts	Ground Polarity	ARMATURE AIR GAP			CONTACT GAPS		CUT-OUT RELAY		Voltage Reg. Test	Current Reg. Amperes
			Cut-Out Relay Inches	Voltage Reg. Inches	Current Reg. Inches	Cut-Out Relay Inches	Voltage Reg. Inches	Closes Volts	Opens Volts or Amps.		
VRS-5102FM, FMT	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	16.0-18.0
VRS-5201, A, AX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	11.0-13.0
VRT-4001A	12	P	.031-.034	.048-.052	.....	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	.....
VRT-4002A, -1	12	P	.031-.034	.048-.052	.....	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	.....
VRT-4003A-1	12	P	.031-.034	.048-.052	.....	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	.....
VRT-4004A	12	P	.031-.034	.048-.052	.....	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	.....
VRT-4005A	12	P	.031-.034	.048-.052	.....	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	.....
VRU-4001A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	7.0-9.0
VRU-4002A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	7.0-9.0
VRU-4004A, AX	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	7.0-9.0
VRU-4101AM	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	7.0-9.0
VRU-4102AM	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	7.0-9.0
VRU-5004, A, AX	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	7.0-9.0
VRV-4001A	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	9.5-10.5
VRV-4002A	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	9.5-10.5
VRV-4003A, B	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	9.5-10.5
VRV-4004A	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	4.8-5.2
VRV-4101A	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	4.8-5.2
VRV-4102A	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	4.8-5.2
VRV-4103A	24	N	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	4.8-5.2
VRV-4201A, AM	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	4.8-5.2
VRV-4202AM	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	4.8-5.2
VRV-5003B	24	P	.048-.052	.048-.052	.048-.052	.015 min.	.....	25.6-27.0	1.9-3.0 A.	23	9.5-10.5
VRW-4001A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	11.0-13.0
VRW-4001BX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8 V.	19	16.0-19.0
VRW-4002A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	13.0-15.0
VRW-4003A	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	15.0-16.0
VRW-4003BX	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8 V.	19	13.0-15.0
VRW-4004A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	15.0-17.0
VRW-4005A	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	15.0-17.0
VRW-4005B, BX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8 V.	19	13.0-15.0
VRW-4005C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8 V.	14	16.0-18.0
VRW-4101AM	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	13.0-15.0
VRW-4102AM	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-7.0	4.1-4.8 V.	14	13.0-15.0
VRW-5003BX	6	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-4.8 V.	19	13.0-15.0
VRW-5005B, BX	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.35-6.75	4.1-5.8 V.	19	13.0-15.0
VRW-5005C	6	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	6.4-6.9	4.1-4.8 V.	14	16.0-18.0
VRX-4001A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	29.0-31.0
VRX-4001B, BX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	29.0-31.0
VRX-4002A	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	29.0-31.0
VRX-4002B	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	25.0-27.0
VRX-4003A, AX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	34.0-36.0
VRX-4003B, BX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	25.0-27.0
VRX-4003C, CX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	29.0-31.0
VRX-4003D	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	25.0-27.0
VRX-4004A	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	29.0-31.0
VRX-4005A, AX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	29.0-31.0
VRX-4401A	12	N	.031-.034	.048-.052	.048-.052	.015 min.	.....	13.0-13.75	8.2-9.3 V.	24	34.0-36.0
VRX-5003CX	12	P	.031-.034	.048-.052	.048-.052	.015 min.	.....	12.8-13.5	8.2-9.3 V.	25	29.0-31.0
VRY-4201A	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	24.0-26.0
VRY-4201B	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	31.0-33.0
VRY-4201C	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	24.0-26.0
VRY-4201D	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	31.0-33.0
VRY-4202A	6	P	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	24.0-26.0
VRY-4203A, B, C, D, E, F, G	6	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	39.0-41.0
VRY-4204A	6	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	39.0-41.0
VRY-4301AU	6	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	40.0-42.0
VRY-4302AU	6	N	.060-.065	.040-.042	.047-.049	.025 min.	.....	6.5-7.0	0.5-6.0 A.	14	40.0-42.0